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GeoScience Abstracts

3-3560 TO 3-3942

Vol. 3, No. 11 November 1961

published monthly by the
AMERICAN GEOLOGICAL INSTITUTE

GEOSCIENCE ABSTRACTS

published by the
American Geological Institute

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GeoScience Abstracts is published monthly, beginning with Volume 1, Number 1 January 1959, and replaces Geological Abstracts which was discontinued by the Geologica Society of America at the end of 1958. The journal has received a grant in aid from th National Science Foundation to provide initial working funds.

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2101 Constitution Avenue, N.W., Washington 25, D. C.

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SERIALS

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Akademiya Nauk SSSR, Izvestiya, Geophysics Series, in English translation (American Geophysical Union). New York.
American Association for the Advancement of Science, Publication. Washington, D.C.
American Geological Institute, AGI Data Sheet. Washington, D.C.
American Geophysical Union, Transactions. Washington, D.C.
American Journal of Science. New Haven, Connecticut.
American Society of Civil Engineers, Hydraulics Division, Journal; Soil Mechanics and Foundations Division, Journal; Surveying and Mapping Division, Journal. Ann Arbor, Michigan
Arkiv för Mineralogi och Geologi (Kungl. Svenska Vetenskapsakademien). Stockholm, Sweden.
Astronautics (American Rocket Society). New York.
California, Dept. of Water Resources, Bulletin. [Sacramento?].
California, Division of Mines, Bulletin. San Francisco.
Canada, Dept. of Mines and Technical Surveys, Geographical Branch, Memoir. Ottawa.
Canada, Geological Survey, Map; Memoir; Paper. Ottawa.
Canadian Mineralogist (Mineralogical Association of Canada). Ottawa.
Carnegie Institution of Washington, Publication. Washington, D.C.
Colorado School of Mines, Mineral Industries Bulletin. Golden.
Deep-Sea Research. London-New York.
Economic Geology (Society of Economic Geologists). Lancaster, Pennsylvania.
Florida, Geological Survey, Information Circular. Tallahassee.
Geochimica et Cosmochimica Acta. London-New York.
Geokhimiya. Geochemistry; a translation of the journal of the Academy of Sciences, U. S. S. R., devoted to geochemistry (Geochemical Society). Ann Arbor, Michigan.
Geological Society of America, Bulletin; Memoir. New York.
Geological Society of India, Journal. Bangalore.
Geologiya Nefti. Petroleum Geology, an English translation (Review of Russian Geology). Alexandria, Virginia.
Geophysics (Society of Exploration Geophysicists). Tulsa, Oklahoma.
GeoTimes (American Geological Institute). Washington, D.C.
Illinois, Agricultural Experiment Station, Bulletin. Urbana.
Illinois, State Geological Survey, Guide Leaflet; [Map]. Urbana.
Journal of Geophysical Research. Washington, D.C.
Kristallografiya. Soviet Physics: Crystallography; a translation of the journal Crystallography of the Academy of Sciences, U. S. S. R. (American Institute of Physics). New York.
The Landman (American Association of Petroleum Landmen). Fort Worth, Texas.
Lapidary Journal. Del Mar, California.
Louisiana, Geological Survey, Folio Series. Baton Rouge.
McLean Paleontological Laboratory, Classics in Paleontology. Alexandria, Virginia.
Maryland, Bureau of Mines, Annual Report. [Annapolis?].
Meddelelser om Grønland (Denmark, Kommissionen for Videnskabelige Undersøgelser i Grønland). Copenhagen.
Mexico, Universidad Nacional, Instituto de Geologia, Paleontologia Mexicana. Mexico, D.F.
Michigan, Geological Survey Division, Water Supply Report. Lansing.
Mineral Industries Journal (Virginia Polytechnic Institute). Blacksburg, Virginia.
Mining Congress Journal. Washington, D.C.
Minnesota Geological Survey, Bulletin. Minneapolis.
Nebraska, State Museum, Special Publication. Lincoln.
New Mexico, State Engineer, Technical Report. Santa Fe.
New York Times. New York.
North Carolina, Division of Mineral Resources, Economic Paper. Raleigh.
Ohio, Division of Geological Survey, Information Circular; Report of Investigations. Columbus.
Ohio Journal of Science. Columbus.
Oil and Gas Journal. Tulsa, Oklahoma.
Ontario, Dept. of Mines, Preliminary Map. Toronto.
Pennsylvania, Geological Survey, Atlas; Bulletin; Information Circular; Progress Report. Harrisburg.
Photogrammetric Engineering (American Society of Photogrammetry). Washington, D.C.
Plateau (Northern Arizona Society of Science and Art, Inc.). Flagstaff, Arizona.
Problems of the North; a translation of Problemy Severa, Akademiya Nauk SSSR (National Research Council of Canada). Ottawa.
Purdue University, Engineering Extension Dept., Engineering Bulletin, Extension Series. Lafayette, Indiana.
Saskatchewan, Dept. of Mineral Resources, Report. Regina.
Science. Washington, D.C.
Seismological Society of America, Bulletin. Berkeley, California.
South Dakota, State Geological Survey, Report of Investigations. Vermillion.
Tennessee, Division of Geology, Information Circular; [Map]; Report of Investigations. Nashville.
Texas, Board of Water Engineers, Bulletin. Austin.
Texas Journal of Science (Texas Academy of Science). Austin.
U.S. Atomic Energy Commission [Publication].

U.S. Geological Survey, Bulletin; Coal Investigations Map; Geophysical Investigations Map; Mineral Investigations Map; Miscellaneous Investigations Map; Professional Paper; Trace Elements Investigations Report; Water-Supply Paper. Washington, D.C.
Washington Academy of Sciences, Journal. Washington, D.C.
Water & Sewage Works. Chicago.
Wisconsin Geological and Natural History Survey, Information Circular. Madison.

DECEMBER ISSUE AND ANNUAL INDEX

The annual author and subject index for 1961 and the December 1961 issue of GeoScience Abstracts will be mailed to subscribers concurrently. Mailing should take place in late December or early January.

PURCHASE OF PUBLICATIONS

Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of GeoScience Abstracts, regrets that it cannot fill purchase orders for abstracted publications other than its own.

GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-3588, 3-3598, 3-3603; Geomorphology 3-3610; Geophysics 3-3684; Mineral Deposits 3-3882; Fuels 3-3895.

3-3560. Campbell, R.B. GEOLOGY, QUESNEL LAKE (WEST HALF), BRITISH COLUMBIA: Canada, Geol. Survey, Map 3-1961 (Map 59-1959, rev.), scale 1:253,440, descriptive notes, 1961, 4 refs.

Preliminary series geological map of approximately 2,300 sq. mi. SE. of Prince George. The upper Proterozoic Kaza group of quartzite and phyllite is conformably overlain by the Cunningham limestone, followed by the Cariboo group of phyllites and quartzites probably of Cambrian age. Mississipian? volcanics and limestone and Permian intrusives and limestones are present but poorly exposed. Sedimentary and igneous rocks ranging in age from Upper Triassic to Cretaceous are mapped as 8 separate map units. Tertiary rocks include dacite, rhyolite, basalts, and some sandstone. The structure in the area is characterized by the northwesterly trends of the folds and major faults. Placer deposits and quartz veins have yielded some Au, but no significant base-metal discoveries have been reported.--B. C. McDonald.

3-3561. Gabrielse, Hubert. GEOLOGY, RABBIT RIVER, BRITISH COLUMBIA: Canada, Geol. Survey, Map 2-1961, scale 1:253,440, descriptive notes, 1961.

Preliminary series geological map of approximately 5,000 sq. mi. of an area bordering on the Yukon where the Alaska Highway enters British Columbia. A thick section of Cambrian and Precambrian clastic sediments, with a coarse conglomerate member, outcrops in a northwesterly plunging anticlinorium in the Terminal Range. Elsewhere in the area a distinctive Lower Cambrian limestone is underlain by a thick section of impure clastic rocks cut by numerous gabbroic sills and dikes. Lower Cambrian consists essentially of a lower quartzite member overlain by a limestone member. Cambro-Ordovician calcareous and argillaceous strata are well exposed in the Kechika Ranges and northern Rocky Mountains. Silurian and Devonian strata are widespread in the northern and eastern parts of the map-area. Although the base of the succession is marked by an unconformity the mutual relations between the 4 units of Siluro-Devonian age are unknown. Disconformably overlying the Middle Devonian carbonates is a clastic Devono-Mississippian sequence of sandstones and shales. Lower Mississippian sandstones and carbonates are tightly infolded in Cambro-Ordovician strata. Typical glacial features are abundant in the Liard plain. Glacial-lake silts and abandoned river channels occur elsewhere in the area. Structural trends are NW. S. of the Liard River and NNE. N. of the river, the 2 blocks being separated by major thrust faults. Placer Au and a barite-witherite-fluorite deposit have been reported.--B. C. McDonald.

3-3562. Dawson, K.R. GEOLOGY, SEVOGLE, NORTHUMBERLAND AND GLOUCESTER COUNTIES, NEW BRUNSWICK: Canada, Geol. Survey, Map 1092A, scale 1:63,360, descriptive notes, 1961, 5 refs.

Geological map of about 200 sq. mi. of the Sevogle River-Miramichi River area. Surficial materials cover 95% of the area. Neither the age nor the stratigraphic position of a fine-grained, well indurated quartzite and slate unit is accurately known but it is probably Ordovician or earlier and possibly correlative with the upper member of the Ordovician Tetagouche group. The lower member of this group includes rhyolites, pyroclastic rocks, and quartz-feldspar porphyries, and is overlain by a unit of basaltic lavas and cherts with a few thin beds of sedimentary rocks. The uppermost member of the Tetagouche group consists of shale and graywacke with minor conglomerate and tuff. A medium- to coarse-grained diabasic gabbro, possibly of Devonian age, is found exclusively in rocks of the Tetagouche group. The flat-lying Pennsylvanian Bathurst formation of conglomerate and sandstone unconformably overlies the Ordovician sediments and is in turn conformably overlain by the Clifton formation sandstones and siltstones of Pennsylvanian age. Generally the rocks become younger from W. to E. in the map-area. The area includes the Roche Long Lac, Timmins, Springer, and Oka-Bathurst mining properties.--B. C. McDonald.

3-3563. Taylor, F.C. GEOLOGY, SHELBURNE, NOVA SCOTIA: Canada, Geol. Survey, Map 44-1960, scale 1:253,440, descriptive notes, 1961, 3 refs.

Preliminary series geological map of approximately 2,500 sq. mi., located on the southernmost tip of Nova Scotia. Extensive glacial debris largely limits the outcrops to the coast and stream valleys. With the exception of a 250-ft.-thick post-Devonian gabbro dike, all outcrops are of Lower Ordovician to Devonian age. Three lithologic units compose the Lower Ordovician Meguma group. From bottom to top they are: Goldenville formation of quartzites, conglomerate, and subgraywacke; staurolite-andalusite and cordierite schists; Halifax formation of slate and argillite. The White Rock formation of Ordovician or Silurian quartzites and slates conformably overlies the Meguma group in the Yarmouth area. Interbedded slates and metamorphosed volcanics are probably correlative with the White Rock formation. Gray biotite granites of Devonian age cut all the bedded rocks in the map-area. The Acadian orogeny produced intricate folding throughout, but no major faults are known. Granite and hornblende diorite are quarried for building stones, and silica is quarried intermittently for refractory purposes. Beryl, molybdenite, and Au have been reported but are of no economic significance.--B. C. McDonald.

3-3564. Ontario, Dept. of Mines. FLANDERS LAKE AREA, DISTRICT OF THUNDER BAY AND ALGOMA: Its: Prelim. Map P.98, scale 1 in. to 1/2 mi., 1961.

3-3565. Jackson, G.D. GEOLOGY, MIMINISKA, ONTARIO: Canada, Geol. Survey, Map 8-1961, scale 1:253,440, descriptive notes, 1961, 8 refs.

Preliminary series geological map of approximately 6,000 sq. mi., just E. of the Pickle Lake-Savant Lake road. Glacial debris covers about 75% of the area. Sedimentary and predominantly basic volcanic rocks compose the oldest exposures. Banded Fe formations, consisting mainly of fine-grained quartz and magnetite-rich bands, are associated with this sedimentary-volcanic sequence. Bedrock of much of the southern part is migmatite, and elsewhere in the area is largely granodiorite, quartz monzonite, and quartz diorite. Acidic and intermediate to ultrabasic rocks compose scattered intrusive bodies. Isoclinal folds occur throughout, with anticlinal structures near Miminiska and Atwood lakes. The main sedimentary belts seem to lie stratigraphically below the main volcanic sequences. Au was mined in the area until 1958; Cu, Co, Ni, and W have been reported. Drilling has indicated that the Fe formations cannot be profitably mined.--B. C. McDonald.

3-3566. Wilson, M. E., and Jean Dugas. GEOLOGY, PERTH, LANARK AND LEEDS COUNTIES, ONTARIO: Canada, Geol. Survey, Map 1089A, scale 1:63,360, descriptive notes, 1961.

Geological map of about 400 sq. mi. of the area surrounding Perth. Roughly, the eastern half of the map-area is underlain by lower Paleozoic sediments of the Ottawa-St. Lawrence lowland; the western half is mainly Precambrian migmatites and altered sediments of the Grenville series. Diorite, with anorthositic facies, is associated with migmatite in the southwestern portion of the area. Large syenitic bodies contain magnetite-ilmenite and produce sharp magnetic anomalies. Most of the Precambrian sediments have been closely folded and granitized. Nepean sandstone, Ordovician or older, is conformably overlain by the Lower Ordovician March and Oxford formations, comprising respectively sandstone interbedded with dolomite, and dolomitic limestone. Potash feldspar, phlogopite, vermiculite, apatite, hematite, magnetite, barite, and graphite have all been of economic interest.--B. C. McDonald.

3-3567. Green, L. H., and J. A. Roddick. GEOLOGY, NAHANNI, YUKON TERRITORY AND DISTRICT OF MACKENZIE: Canada, Geol. Survey, Map 14-1961, scale 1:253,440, descriptive notes, 1961.

Preliminary series geological map covering approximately 5,200 sq. mi. spanning the Yukon-District of Mackenzie border around the South Nahanni River. Heavy glaciation and existing glaciers suggest that this area was a center of ice-accumulation in the Pleistocene. A thick sequence of Precambrian sediments comprises quartzites and shale overlain by quartzites, siltstone, and dolomite. Overlying the Precambrian with apparent conformity is a sequence of limestone and dolomite arbitrarily included in the Cambrian. Next in the sequence is a trilobite-bearing siltstone of Lower Cambrian age. Stratigraphically above this bed is a thick unit of thin-bedded limestone and siltstone of Middle and Upper Cambrian to Ordovician age. A distinctive Siluro-Ordovician unit composed of dolomite underlain by quartzite, unconformably overlies the Cambro-Ordovician limestone-siltstone beds. A Silurian graptolitic shale in the western portion of the area is equivalent to a more calcareous facies in the E. Middle Devonian gray crinoidal limestones have been correlated with the Nahanni formation E. of the map-area. Granitic intrusives are of Cretaceous age. The drainage pattern reflects a NW. structural trend involving complex deformation of Precambrian and Paleozoic strata. A tungsten occurrence in the skarn near Flat River is being developed, but gossans and iron stains are the main items of further economic interest.--B. C. McDonald.

3-3568. Sanford, Thomas H., Jr., and others. GEOLOGY OF THE HUNTSVILLE QUADRANGLE, ALABAMA: U. S. Geol. Survey, Misc. Inv. Map I-329, scale 1:24,000, lat. 34°37'30"-34°45'N., long. 86°30'-86°37'30"W., 1961.

This geologic map covers about 60 sq. mi. in Madison County. Included are the outcrop patterns of the bedrock formations, a generalized columnar section, structure-contour map on the contact of the Chattanooga shale and the Fort Payne chert, map showing thickness of surficial deposits, structure section, and brief text describing the formations exposed and the geologic structure.--U. S. Geol. Survey.

3-3569. Scott, Glenn R. PRELIMINARY GEOLOGIC MAP OF THE INDIAN HILLS QUADRANGLE, JEFFERSON COUNTY, COLORADO: U. S. Geol. Survey, Misc. Inv. Map I-333, scale 1:24,000, lat. 39°30'-39°37'30" N., long. 105°07'30"-105°15'W., 1961.

3-3570. Illinois, State Geological Survey. MINERAL INDUSTRIES OF ILLINOIS. Compiled and prepared by the Educational Extension Division: scale approx. 1 in. to 8 mi., 1955, rev. 1961.

Map shows location of primary processing plants; coal mines; areas underlain by Pennsylvanian rocks containing commercial deposits of coal, limestone, fireclay, and shale; producing oil and gas pools; areas underlain by limestone and dolomite of Ordovician, Silurian, and Mississippian age; limestone and dolomite quarries; sand and gravel deposits; clay deposits and products; fluorspar and Pb and Zn mining districts. Other mineral products, not specifically noted on the map, are also listed.--A. C. Sangree.

3-3571. Illinois, State Geological Survey. SHIPPING COAL MINES IN ILLINOIS. By Jack A. Simon: scale 1:500,000, table, 1961.

Map indicates shaft, slope, and strip mines (shipping mines and local mines producing 25,000 tons or more in 1960), freight rate districts, coal handling docks, and the boundaries of the Pennsylvanian system. Table lists the mines by name and gives the following information for each: coal number or name, county, location, mine index number, freight rate district.--A. C. Sangree.

3-3572. Bromfield, C. S., and Chester T. Wrucke. RECONNAISSANCE GEOLOGIC MAP OF THE CEDAR MOUNTAINS, GRANT AND LUNA COUNTIES, NEW MEXICO: U. S. Geol. Survey, Mineral Inv. Map MF-159, scale 1:62,500, 1961.

3-3573. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF PART OF THE ALBURTIS QUADRANGLE, LEHIGH, BERKS, AND NORTHAMPTON COUNTIES, PENNSYLVANIA: U. S. Geol. Survey, Geophys. Inv. Map GP-266, scale 1:24,000, contour interval 50 gammas, lat. 40°30' - 40°45' N., long. 75°30' - 75°45' W., 1961.

3-3574. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF PART OF THE BERNVILLE QUADRANGLE, BERKS COUNTY, PENNSYLVANIA: U. S. Geol. Survey, Geophys. Inv. Map GP-273, scale 1:24,000, contour interval 50 gammas, lat. 40°22'30" - 40°30' N., long. 76° - 76°07'30" W., 1961.

3-3575. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF THE GLEN ROCK AND PART OF THE NEW FREEDOM QUADRANGLES, YORK COUNTY, PENNSYLVANIA: U. S. Geol. Survey, Geophys. Inv. Map GP-272, scale 1:24,000, contour interval 50 gammas, lat. 39°42'30" - 39°52'30" N., long. 76°37'30" - 76°45' W., 1961.

3-3576. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF PART OF THE HUMMELSTOWN QUADRANGLE, DAUPHIN COUNTY, PENNSYLVANIA: U. S. Geol. Survey, Geophys. Inv. Map GP-267, scale 1:24,000, contour interval 50 gammas, lat. 40°15' – 40°22'30"N., long. 76°37'30" – 76°45' W., 1961.

3-3577. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF PART OF THE PALMYRA QUADRANGLE, DAUPHIN AND LEBANON COUNTIES, PENNSYLVANIA: U. S. Geol. Survey, Geophys. Inv. Map GP-268, scale 1:24,000, contour interval 50 gammas, lat. 40°15' – 40°22'30"N., long. 76°30' – 76°37'30"W., 1961.

3-3578. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF THE RED LION QUADRANGLE, YORK COUNTY, PENNSYLVANIA: U. S. Geol. Survey, Geophys. Inv. Map GP-271, scale 1:24,000, contour interval 50 gammas, lat. 39°52'30" – 40° N., long. 76°30' – 76°37'30" W., 1961.

3-3579. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF THE YORK QUADRANGLE, YORK COUNTY, PENNSYLVANIA: U. S. Geol. Survey, Geophys. Inv. Map GP-270, scale 1:24,000, contour interval 50 gammas, lat. 39°52'30" – 40° N., long. 76°37'30" – 76°45' W., 1961.

3-3580. Hardeman, William D., and Robert A. Miller. MINERAL RESOURCES AND MINERAL INDUSTRIES OF TENNESSEE: Tennessee, Div. Geology, [Map], scale 1:500,000, 1959, pub. 1960.

This map is printed in color, at a scale of 1 in. to 8 mi. Printed below the map is a summary of raw materials and associated industries, which includes information on geographic location, production, value, and uses for each commodity.--R. J. Floyd.

3-3581. Moxham, Robert M., and D. Hoye Eargle. AIRBORNE RADIOACTIVITY AND GEOLOGIC MAP OF THE COASTAL PLAIN AREA, SOUTHEAST TEXAS: U. S. Geol. Survey, Geophys. Inv. Map. GP-198, scale 1:250,000, lat. 28°-29°45'N., long. 97°-99°15'W., 1961.

Airborne radioactivity surveys have been made in an area of about 15,000 sq. mi. in SE. Texas as part of a geophysical and geologic investigation of U deposits in that area. Results for about 10,000 sq. mi. in the central part of the survey are shown on this map. Abnormal radioactivity is indicated over large areas extending tens of miles from known U deposits. --U. S. Geol. Survey.

3-3582. Callaghan, Eugene, and Raymond L. Parker. GEOLOGIC MAP OF PART OF THE BEAVER QUADRANGLE, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-202, scale 1:62,500, lat. 38°19'-38°30' N., long. 112°30'-112°38'W., 1961.

An area of about 42 sq. mi. in the Beaver quadrangle on the western side of the Tushar Mountains contains volcanic and intrusive rocks of Miocene(?) age and volcanic rocks of Pliocene(?) age. This area is a part of the alunite-rich volcanic province in the Marysvale region, Utah. Mineral deposits include Au, Ag, alunite, and U.--U. S. Geol. Survey.

3-3583. Cashion, William B. GEOLOGY AND FUELS RESOURCES OF THE ODERVILLE–GLENDALE AREA, KANE COUNTY, UTAH: U. S. Geol. Survey, Col. Inv. Map C-49, scale 1:62,500, 1961.

Areal distribution of rocks of Jurassic, Late Cretaceous, Tertiary, and Quaternary age, alluvium, faults, coal zones, basalt flows, and structure contours are shown on this geologic map of a 440 sq. mi. area in northwestern Kane County. Coal sections, 2 composite stratigraphic sections, a diagramatic restored section, tables showing original coal reserves totaling more than 3 1/2 billion short tons, coal analyses, and descriptive text are included.--U. S. Geol. Survey.

3-3584. Tooker, Edwin W., and Ralph J. Roberts. PRELIMINARY GEOLOGIC MAP AND SECTIONS OF THE NORTH END OF THE OQUIRRH RANGE (MILLS JUNCTION, GARFIELD, AND MAGNA 7 1/2-MINUTE QUADRANGLES) TOOELE AND SALT LAKE COUNTIES, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-240, scale 1:24,000, lat. 40°37'30"-40°45'N., long. 112°03'45"-112°20'W., 1961.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Structural Geology 3-3634; Stratigraphy 3-3653; Mineral Deposits 3-3883.

3-3585. Putallaz, Jean. GÉOLOGIE DE LA PARTIE MÉDIANE DE TRAILL Ö (GROENLAND ORIENTAL): [Geology of the Central Part of Traill Ø, (East Greenland)] Meddelelser om Grønland, v. 164, no. 2, 84 p., 14 illus., 2 maps, 4 fold. pls., 1961, 67 refs.; text in French, summary in English.

Traill Ø (72°-73°N., 22°-25°W.) is located in the external fjord zone, E. of the Caledonian range. The western part of the island is formed by folded Devonian molasse. A major fault separates these Devonian formations from upper Paleozoic and Mesozoic rocks to the E. The present survey covers about 1,700 sq. km. The morphology is characterized by table mountains, gently dipping to the W., and separated by wide valleys and rather strongly peneplaned regions.

The Carboniferous is formed by thick delta series, mostly arkoses and conglomerates, from bottom to top: the Karupelv series, the variegated series, and the "Domkirken serie."

The "Domkirken serie," with its boulder (up to 35 cm.) conglomerates suggests a renewing of the orogenic movements during the upper Carboniferous or the Lower Permian. The Zechstein, Lagunal formation, is transgressive on the "Domkirken serie." The Zechstein starts with a basal conglomerate, followed by limestone, dolomitic limestone, gypsum, and Posidonomya-bearing shales. The thickness averages 110-140 m. The Zechstein is a very clear key zone between the Carboniferous and the Triassic Wordie Creek formation which caps some mountain tops W. of the Bordbjerget fault.

The Jurassic, exposed E. of the Maanedal fault, includes the Yellow series (Bathonian, Callovian, middle Oxfordian) and the Black series (upper Oxfordian to Kimmeridgian). The base of the Yellow series was observed in the Mols Bjerge, where this series is transgressive on the Mt. Nordenskjöld formation. The base of the Yellow series is formed by conglomerates with angular pebbles of limestone and quartzite. Higher up are continental and littoral deposits. The Yellow series reaches at least 1,300 m. Traill Ø was probably located in the most active part of a huge subsiding area during the deposition of the Yellow series. Cardioceras maltonense and Cardioceras vagum Ilovaisky, middle Oxfordian ammonites, show that the top of the Yellow series corresponds to the Plicatilis zone.

Cretaceous deposits are for the most part black, fine-grained sandstones with a clayey matrix and black shales. Basalt sills are common. The following stages have been identified: Infravalanginian, Valanginian, lower Aptian, Albian-Cenomanian, Turonian, Senonian, and Campanian. Most of the Upper Jurassic and Lower Cretaceous deposits were eroded away prior to the Albian-Cenomanian transgression, which, in the Traill Ø region, is a southern extension of the older, Aptian-Albian, transgression recognized between 73° and 75° N. A thickness of 1,200 m. is estimated for the Albian-Cenomanian.

A pattern of antithetic faults trends NNE. or NNW. An anticline in the Svinhufvuds Bjerge trends towards the NE. and has a large radius of curvature. This and other gentle folds are of Variscan age. Four major faults and several minor faults have been observed. The major faults are: a) Bordbjerget fault, b) Maanedal fault, c) Mols Bjerge fault, and d) Vaelddal fault. The first 3 with their down-faulted blocks to the E. belong to the general fault system of the E. coast of Greenland, while the last one, with its lowered block to the W., is related to the syenitic intrusion located in the SE. corner of the island.

The Bordbjerget fault is syn- and post-basaltic. The Maanedal fault originated during Cenomanian; however, the major movements occurred during and after basaltic intrusion. The Mols Bjerge fault is older. Other major movements of this fault took place during and after the basaltic intrustion.

An important pre-Albian-Cenomanian fault is assumed between the Mols Bjerge, the Maanedal, and the Vaelddal faults. The Vaelddal fault is early Tertiary.

From Carboniferous to early Tertiary, the region between Kong Oscars and Kejser Franz Josephs fjords was subdivided into a few important blocks, perhaps into only 2 blocks. The present pattern of numerous blocks is the result of later Tertiary movement.--M. Russell, from English summ.

3-3586. Edmonton Geological Society. THIRD ANNUAL FIELD TRIP GUIDE BOOK. JASPER: 104p., illus., maps (geol. map in pocket, 2 sheets, scale 1 in. to 1 mi.), secs. (1 in pocket), Edmonton, Alberta, Aug. 1961, refs.

This guidebook for the 1961 field trip contains introductory remarks on the trip by Theo. A. Link, 5 geologic papers on the Jasper area by various authors (separately abstracted below in the order in which they appear in the guidebook), and 3 road logs compiled by G. M. Smart. The road logs cover the following areas: 1) Jasper to Miette Hot Springs; 2) Jasper vicinity to beyond Geikie Station on the Yellowhead highway; 3) Celestine Lake road to Mount Greenock.--A. C. Sangree.

3-3587. Charlesworth, H. A. K., and others. PRECAMBRIAN GEOLOGY IN THE JASPER-GEIKIE AREA (In: Edmonton Geological Society. Third Annual Field Trip Guide Book. Jasper: p. 3-13, 2 geol. maps, Edmonton, Alberta, 1961, 6 refs.

In ascending order Precambrian rocks near Jasper, Alberta, are divisible into Old Fort Point, Miette, and Jasper formations. Respectively, these are argillites and siltstones with some limestones and limestone-breccias; argillites, sandstones, and pebble-conglomerates; and sandstones and conglomerates with some argillites and algaloid carbonates near the top. The Miette has deltaic or fluviatile characteristics, and the other 2 formations are probably of shallow-water marine origin. The materials for all 3 formations were apparently derived from a metamorphic and igneous terrain lying to the NE. The strata, which now belong to the greenschist metamorphic facies, lie within the Pyramid thrust sheet and have been folded into a series of anticlinoria and synclinoria.--Auth.

3-3588. Mountjoy, Eric Walter. ROCKY MOUNTAIN FRONT RANGES ALONG THE ATHABASCA VALLEY, JASPER NATIONAL PARK, ALBERTA (In: Edmonton Geological Society. Third Annual Field Trip Guide Book. Jasper: p. 14-42, 4 illus., 2 geol. maps (1 in pocket, 2 sheets, scale 1 in. to 1 mi.), table, Edmonton, Alberta, 1961) 45 refs.

Strata exposed in Athabasca Valley range from Precambrian to Cretaceous in age. Lower Paleozoic beds include the Lower Cambrian Gog formation, an interbedded shale and carbonate unit, Titkana and Pika formations of Middle Cambrian age, the Middle and Upper Cambrian Arctomys formation and the Upper Cambrian Lynx formation. Ordovician Chushina formation occurs in the SW. Units above the Arctomys formation are progressively truncated from W. to E. beneath Devonian strata.

The area is subdivided tectonically into the western foothills, eastern front ranges, and western front ranges, each containing 2 major thrust sheets, and main ranges. Available data suggest that the major thrusts remain separate at depth and that regional decollement is absent. The geology of Athabasca Valley is outlined by 2 detailed maps and 4 cross-sections.--Auth.

3-3589. Drummond, James M. DETAILED CARBONIFEROUS CORRELATIONS BETWEEN MOUNT GREENOCK AND BOX CANYON, SOUTHERN CANADIAN ROCKIES (In: Edmonton Geological Society. Third Annual Field Trip Guide Book. Jasper: p. 43-55, sec. (in pocket), Edmonton, Alberta, 1961) 23 refs.

Carboniferous rock units correlate uniformly between Box Canyon near Nordegg and Mount Greenock near Jasper, Alberta, except for facies changes at the contacts of the Mount Head/Turner Valley and Shunda/Pekisko formations.

The Greenock formation is considered obsolete, and the 2 highest members referred to the Rocky Mountain group, while the lowest one is assigned to the upper part of the Mount Head formation. The Mount Greenock section is subdivided into rock units used in the S. of Alberta.--Auth.

3-3590. Nelson, Samuel J., and Harold R. Rudy. TUNNEL MOUNTAIN-RUNDLE RELATIONSHIPS, CARBONIFEROUS OF THE SOUTHERN CANADIAN ROCKY MOUNTAINS (In: Edmonton Geological Society. Third Annual Field Trip Guide Book. Jasper: p. 56-70, map. 2 secs., Edmonton, Alberta, 1961) 24 refs.

The apparently conformable contact between carbonates of the Rundle group and the overlying silty-sandy beds of the Tunnel Mountain formation is traced by means of 10 sections in the Canadian Rocky Mountains from Mount Darrah in the Flathead area, N. to Mount Greenock near Jasper, Alberta, a distance of about 300 mi. The line of section is north-northwesterly, approximately paralleling the trend of the mountains.

The Tunnel Mountain-Rundle contact is considered to become diachronically older from S. to N., and (with less evidence) from W. to E. In the S. the contact is interpreted as being Early Pennsylvanian in age. Further N. at Mount Rae (=Storm Creek) and Tunnel Mountain (Banff area) it straddles the Mississippian-Pennsylvanian boundary. E. and N. of Tunnel Mountain the contact becomes early Chesterian or late Meramecian.--Auth.

3-3591. McGugan, Alan, and June E. Rapson. PERMIAN STRATIGRAPHY, AND THE POST-CARBONIFEROUS UNCONFORMITY, JASPER AREA, ALBERTA (In: Edmonton Geological Society. Third Annual Field Trip Guide Book. Jasper: p. 71-81, 6 figs. incl. 2 maps, secs., Edmonton, Alberta, 1961) 18 refs.

Uppermost Paleozoic beds in the vicinity of Jasper, Alberta, consist of a sandstone unit between 20 and 100 ft. thick, of Permian and/or Triassic age, underlain by a Permian chert unit 15 to 100 ft. thick. A distinctive basal Permian conglomerate contains derived materials ranging from Upper Mississippian to Permian in age and lies upon unevenly eroded Upper Mississippian or Pennsylvanian strata.

The Permian Ishbel formation of the Banff area appears correlative with the Jasper area chert unit and basal conglomerate, and hence with a chert interval at Wapiti Lake in the Rockies of northeastern British Columbia. Lower Permian beds at the latter locality appear to be absent in Athabasca Valley but probably occur as derived fragments in the basal conglomerate at Deer Creek 15 mi. to the N.--Auth.

3-3592. Illinois, State Geological Survey. GEOSCIENCE FIELD TRIP, GUIDE LEAFLET, SALEM AREA, MARION COUNTIES [SIC], CENTRALIA AND SALEM QUADRANGLES: Its: Guide Leaflet 60-A, 11 p., map (separate), 4 secs., 2 pls., 1960.

The Salem oil pool is the largest, in terms of production, in Illinois. Oil accumulated in the Salem field in a dome or doubly plunging anticline. The Duquoin monocline lies to the W. on whose western flank the No. 6 coal was mined. The strata underlying the Salem region are among the youngest Pennsylvanian rocks in Illinois. Sandstones, shales, and limestones crop out in this vicinity. One limestone underlying the Omega limestone contains abundant pelecypod and gastropod fossils.

A low-lying moraine rises 30 to 60 ft. above the dissected Illinoian till plain. The till plain has been exposed to weathering longer than that of the Wisconsinan. Consequently, the formation of "hardpan" or zone of clay accumulation has created a drainage problem throughout much of southern Illinois.--I. E. Odum and G. M. Dow.

3-3593. Illinois, State Geological Survey. GEOLOGICAL SCIENCE FIELD TRIP, GUIDE LEAFLET, GRAFTON AREA, JERSEY COUNTY, JERSEYVILLE, HARDIN, ST. CHARLES, AND BRUSSELS QUADRANGLES: Its: Guide Leaflet 60-B, 12 p., 2 maps (1 separate), 3 secs., 2 pls., table, 1960.

Grafton is located in southwestern Illinois along the Mississippi River. The region is a classical area for study of middle and Lower Mississippian and Devonian stratigraphy of Illinois. Rocks ranging in age from Middle Ordovician to middle Mississippian are exposed on the Cap au Gres monocline which trends E.-W. across the region.

Evidence of glaciation during the Illinoian and Wisconsinan stages is given by moraines, loess-covered bluffs, and depositional terraces.

Geodes from the Warsaw shale and fossils from the Devonian Cedar Valley limestone make this an interesting region for collectors.--I. E. Odum and G. M. Dow.

3-3594. Illinois, State Geological Survey. GEOLOGICAL SCIENCE FIELD TRIP, GUIDE LEAFLET, WOODSTOCK AREA, HARVARD, MCHENRY, AND GENOA QUADRANGLES: Its: Guide Leaflet 60-C, 13 p., 3 maps (1 separate), 2 pls., table, 1960.

The Woodstock region contains some of the best developed glacial features of the Wisconsinan stage in Illinois. Glacial features seen include the Shelbyville, Bloomington, Marseilles, and W. Chicago moraines, outwash plains, a subglacial channel, knob and kettle topography, and gravel fans. Overriding of the W. Chicago moraine over the older Marseilles and Bloomington moraines is excellently illustrated at numerous localities in the region.

The bedrock underlying the region is of Ordovician and Silurian age. The contact between these systems is exposed in a quarry near Marengo. Ordovician limestones are highly fossiliferous at the quarry.--I. E. Odum and G. M. Dow.

3-3595. Illinois, State Geological Survey. GEOLOGICAL SCIENCE FIELD TRIP, GUIDE LEAFLET, MILAN-ROCK ISLAND AREA, ROCK ISLAND AND HENRY COUNTIES, MILAN, COAL VALLEY, PORT BYRON, GREEN ROCK, DAVENPORT EAST & SILVIS QUADRANGLES: Its: Guide Leaflet 60-D, 16 p., 9 maps (1 separate), 2 pls., table, 1960.

The Milan-Rock Island area is near the confluence of the Rock and Mississippi rivers in northwestern Illinois. The region has a complicated Pleistocene history, including Illinoian and Wisconsinan glaciation, and exhibits glacial lakes, terraces, fossil soils, and drainage adjustments. Blocking of the pre-Wisconsinan southeastern course of the Mississippi River by the Wisconsinan ice sheet diverted the Mississippi to its present course along the western border of Illinois and caused the erosion of the rock-walled Cordova Gorge.

The bedrock is of Pennsylvanian, Devonian, and Silurian age. The Devonian and Silurian limestones were severely eroded during the Mississippian. The Pennsylvanian sediments are relatively thin, but are considerably thicker where they fill depression and solution cavities in the underlying limestone.

Geologic features include a coal mine in the Rock Island No. 1 Coal, Devonian limestone illustrating extensive brecciation, the Cordova Gorge, and a quarry in fossiliferous Devonian limestone.--I. E. Odum and G. M. Dow.

3-3596. Illinois, State Geological Survey. GEOLOGICAL SCIENCE FIELD TRIP, GUIDE LEAFLET, PANA AREA, MONTGOMERY, CHRISTIAN AND SHELBY COUNTIES: Its: Guide Leaflet 60-E, 11 p., 3 maps (1 separate), 2 pls., 2 tables, 1960.

Glacial topography is well displayed in the Pana region. Most prominent is a broad ridge trending NE.-SW. formed during the Illinoian stage of glaciation and generally considered to be a morainal feature. Further glacial effects are exhibited by the broad alluviated valley of Robinson Creek, formed by the meltwater from the Wisconsinan glacier that built its terminal moraine 4 mi. to the NE. at Shelbyville.

Kames are prominent features in the area.

Pennsylvanian strata underlying the glacial deposits crop out in several places. The area includes an abandoned coal mine that worked the Herrin (No. 6) coal and a quarry producing the Millersville limestone, an unusually thick (32 ft.) Pennsylvanian limestone.--I. E. Odum and G. M. Dow.

3-3597. Illinois, State Geological Survey. GEOLOGICAL SCIENCE FIELD TRIP, GUIDE LEAFLET, HARRISBURG AREA, SALINE AND GALLATIN COUNTIES, HARRISBURG AND EQUALITY QUADRANGLES: Its: Guide Leaflet 60-F, 12 p., 3 maps (1 separate), sec., 2 pls., table, 1960.

The Harrisburg region is in southeastern Illinois adjacent to the Shawnee Hills, an E.-W. faulted and folded belt deformed sometime between the end of the Pennsylvanian and the beginning of the late Cretaceous. The Shawneetown fault that parallels the front of the Shawnee Hills is the largest in the state. It begins near Shawneetown and trends westward to beyond Horseshoe, where it swings SW. and merges into a large anticline. Also in this immediate area is the Eagle Valley syncline. During the deformation igneous rocks were intruded, and fluorspar and other minerals were formed. The bedrock is of Mississippian and Pennsylvanian age.

The boundary of Illinoian glaciation crosses the area just to the N. of the Shawnee Hills. During the Wisconsinan stage, meltwater that ponded in the Saline River valley formed a large glacial lake in the area. An exposure of the Shawnee fault zone, a double seam strip mine in lower Pennsylvanian coals, and a quarry in fossiliferous Mississippian limestone are present in the area.--I. E. Odum and G. M. Dow.

3-3598. Campbell, Arthur B. GEOLOGY AND MINERAL DEPOSITS OF THE ST. REGIS-SUPERIOR AREA, MINERAL COUNTY, MONTANA: U. S. Geol. Survey, Bull. 1082-I, p. 545-612, 7 figs., 5 pls. (in pocket), incl. col. geol. map, scale 1:62,500, 7 tables, 1960, 37 refs.

The St. Regis-Superior area occupies about 300 sq. mi. in northwestern Montana and includes parts of the Squaw Peak Range and Coeur d'Alene Mountains of the northern Rocky Mountains physiographic province. Nearly 50,000 ft. of metasedimentary rocks of the Precambrian Belt series, chiefly varieties of quartzite and argillite, underlies most of the area. The Belt series is informally subdivided with reference to the top of the Wallace formation into lower and upper parts. In this area, the lower part of the Belt series is divided into the Prichard, Burke and Revett, St. Regis, and Wallace formations, in order of decreasing age, and the upper part of the Belt series or the Missoula group is divided into the Spruce, Lupine, Sloway, and Bouchard formations, and an unnamed feldspathic quartzite at Rock Rabbit Ridge, also from oldest to youngest. Formations in the lower part of the Belt series are correlated with formations of the same names in the Coeur d'Alene district, and formations in the upper part of the Belt series are tentatively correlated in part with formations of the Missoula group in the vicinity of Missoula, Montana. Paleozoic quartzite, shale, limestone, and dolomite crop out in several localities in the southeastern part of the area. The limestone unit contains fragments of a single species of Glossopleura of early Middle Cambrian age which, together with lithologic similarities, has been used to correlate at least the quartzite, shale, and limestone part of this Paleozoic sequence with the Flathead sandstone, Gordon shale, and Damnation limestone sequence known elsewhere in northwestern Montana. Several small diabasic dikes and sills are present in the area, generally associated with northwestward-trending faults.

The major faults generally trend northwestward and are considered to be part of the Lewis and Clark structural line. The Osburn fault, the major element of the Lewis and Clark line through the Coeur d'Alene district and western Mineral County, has been traced to the E. edge of the St. Regis-Superior area, thus extending the mapped length of the fault to about 100 mi. Evidence indicates that this major fault has diminished in intensity in this area and that most of the stress has been relieved along the Boyd Mountain fault that apparently splits from the Osburn fault a few miles W. of St. Regis. Stratigraphic and structural evidence indicates a strike-slip right-lateral movement of about 3 mi. along the Osburn fault. Horizontal stratigraphic separation along the Boyd Mountain fault indicates a right-lateral movement of about 13 mi.

Low-grade regional metamorphism of the sedimentary rocks in the area has caused the recrystallization of quartz grains and the formation of sericite. Argillite and quartzite have been converted to phyllite and foliated quartzite by dynamic metamorphism in a large area N. of the central part of the Osburn fault. Some of the shear zones contain a large amount of introduced carbonate minerals.

From 1901 through 1953 this area has produced 8,086,827 lb. of Zn, 7,932,958 lb. of Pb, 2,053,715 lb. of Cu, 584,168 fine oz. of Ag, and 588 fine oz. of Au. The Pb, An, and Ag have come chiefly from veins in highly foliated rocks near the Osburn fault zone. The attitudes of these veins are controlled in large part by the cleavage. The principal ore minerals are galena, sphalerite, tetrahedrite, and boulangerite, and the gangue minerals are quartz, carbonate materials, and barite. Most of the Cu has come from the Amador vein where chalcopyrite and bornite are the principal ore minerals, and the gangue minerals are pyrite, quartz, and carbonate minerals. The Amador vein occurs in a belt of Cu deposits that extends westward into the Coeur d'Alene district. These Cu deposits may be genetically associated with diorite dikes and sills lying within the same belt.

Fluorspar has been found in 3 closely spaced prospects along a northward-trending zone of brecciation and small-scale folding in Dry Creek valley. Incomplete production records show that 781 tons of fluorspar has been shipped from 2 of these prospects.--Auth.

3-3599. Robinson, G. D. ORIGIN AND DEVELOPMENT OF THE THREE FORKS BASIN, MONTANA: Geol. Soc. America, Bull., v. 72, no. 7, p. 1003-1013, 2 maps, July 1961, 28 refs.

The Three Forks Basin sprawls where the intricately deformed sedimentary and volcanic rocks of the Disturbed Belt along the Rocky Mountain front are faulted against the Precambrian metamorphic rocks that make the core of the Tobacco Root, Madison, Gallatin, and Beartooth ranges. Its eastern edge is linear, controlled by steep faults at the W. front of the Bridger Range. All other boundaries are sinuous and show little sign of structural control.

Tertiary deposits in the basin, rich in contemporaneous rhyolitic and latitic ash, are about equally of lake, bolson, and stream origin. The western part of the basin is dominated by moderately folded Eocene and lower Oligocene rocks, more than 2,000 ft. thick. They dip eastward beneath apparently unfolded upper

Miocene and Pliocene rocks, more than 1,300 ft. thick, that also dip gently eastward to the basin edge.

Thin but extensive Quaternary deposits lying unconformably on the Tertiary and pre-Tertiary rocks are mainly of rounded terrace and flood-plain gravel, angular fan gravel, and wind-blown silt.

The basin began as part of an E.-flowing stream system that developed in Late Cretaceous and Paleocene time, concurrently with Laramide folding and thrusting; the faulted contact between metamorphic and sedimentary rocks was especially erodible and became a main drainage way. Recurrent uplift to the W. throughout the Tertiary provided gradient and load to the streams; additional load was provided by showers of ash from unknown vents. Relative uplifts of the Bridger Range in Eocene and early Oligocene time, and again in late Miocene and Pliocene time, impeded flow from the basin and led to deposits in channels, flood plains, and lakes. During most of Oligocene and Miocene time, however, the basin was being eroded. By the end of the Tertiary the basin was deeply filled and became part of a regional surface of low relief. Regional northwestward tilting stimulated headward erosion of the Missouri River which then captured the formerly E.-draining or closed basin. The Tertiary deposits have been deeply eroded, and the rugged pre-basin surface partly exhumed.--Auth.

3-3600. Schultz, C. Bertrand, and Thompson M. Stout. **FIELD CONFERENCE ON THE TERTIARY AND PLEISTOCENE OF WESTERN NEBRASKA. Guide Book for the Ninth Field Conference of the Society of Vertebrate Paleontology: Nebraska, State Mus., Spec. Pub. no. 2, 55 p., 47 figs. incl. illus., maps, charts, July 1961, 139 refs.**

The field conference took place from July 31 to Aug. 4, 1961. Its purpose was to consider recent work and problems in stratigraphy and vertebrate paleontology concerned with deposits ranging in age from Oligocene through Pleistocene, in western Nebraska. The guidebook contains an introductory section on stratigraphy and paleontology; faunal list of the oreodonts from Nebraska, by C. B. Schultz and C. H. Falkenbach; field trip itinerary.--A. C. Sangree.

3-3601. Orkild, P. P., and J. S. Pomeroy. **GEOLOGIC RECONNAISSANCE OF THE TOPOPAH SPRING AND TIMBER MOUNTAIN QUADRANGLES, NYE COUNTY, NEVADA: U. S. Geol. Survey, Trace Elements Inv. Rept. 757, 20 p., 2 figs. (1 in pocket, geol. map and legend), table, 1960, 4 refs.**

The quadrangles cover about 500 sq. mi. in southern Nye County, about 90 mi. NW. of Las Vegas. They lie mostly within the Nevada Test Site. Most of the exposed rocks are part of a Tertiary to Quaternary volcanic sequence consisting of tuffs, welded tuffs, rhyolite, basalt, vitrophyre, and siliceous plugs. Underlying the volcanic rocks are carbonate and siliceous rocks of Paleozoic age that crop out in the central and E. parts of the Topopah Spring quadrangle. Alluvial deposits of Quaternary age are present in valleys and canyons and cover Jackass Flats and a large area in the central part of the Timber Mountain quadrangle. The volcanic rocks have been broken by many NW. to NE. steeply dipping faults that displaced the rocks as much as 300 ft. vertically. In the Calico Hills a questionable thrust fault cuts the Paleozoic rocks. Folds are rare.--From auth., p. 4, 7-8.

3-3602. Ohio Academy of Science, Section of Geology. **GUIDE TO THE THIRTY-SIXTH ANNUAL FIELD CONFERENCE... APRIL 22 & 23, 1961. GEOLOGY OF THE CINCINNATI REGION: 21 p., 7 figs., 6 pls., [1961], 12 refs. Available from: Ohio Division of Geological Survey, 155 South Oval Drive, Ohio State University, Columbus 10, Ohio.**

The guidebook contains maps showing the field trip route, relief and bedrock topography of the area, effects of glaciation, bedrock geology, and surficial geology; a cross section of geologic formations; and drawings of fossils. A commercial collector for ground water is described and illustrated.

The richly fossiliferous Upper Ordovician bedrock in the vicinity of Cincinnati consists, for the most part, of thin horizontal layers of limestone and shale, some of which was covered by glacial deposits and later reexposed by erosion. The Ohio River near Cincinnati is a composite stream whose present course is the product of at least 2 glacial advances. The major advance of later glaciation (Wisconsin) stopped N. of Cincinnati but pushed tongues of ice down the larger valleys in which were laid down deposits that contain much ground water today.--P. Smyth.

3-3603. Miller, John T. **GEOLOGY AND MINERAL RESOURCES OF THE LOYSVILLE QUADRANGLE, PENNSYLVANIA: Pennsylvania, Geol. Survey, Atlas A127, 47 p., 8 figs., geol. map (in pocket), scale 1:24,000, secs. (in pocket), 1961, 38 refs.**

This report is a brief preliminary one accompanying the geologic map of the Loysville 15-min. quadrangle. The Loysville quadrangle lies in the southern part of the Ridge and Valley section of the folded Appalachians in central Pennsylvania and stratigraphically and structurally is characteristic of this province. The units mapped are all rock units and extend from the Martinsburg formation at the base to the Catskill formation at the top. The age of the rock units is from Upper Ordovician to Upper Devonian. One new member and 2 new formations are named and mapped in this report. They are: the Silurian Cabin Hill member of the Rose Hill formation; the Silurian Mifflintown formation, a redefined rock unit composed of the Keefer, Rochester, and McKenzie units, now reduced to member rank for this area; and the Devonian Sherman Ridge formation at the top of the Hamilton group.

The folds of the Loysville quadrangle combine similar and parallel fold characteristics. Competent units form parallel folds, and imcompetent units form similar folds, resulting in disharmonic relationships. Faults are primarily associated with competent units and are mostly high angle reverse faults. Overturning to the NW. is not regional; many axial planes of folds dip NW. as do some faults.

Exploitation of mineral resources is essentially nil, with few possibilities for future expansion.--Auth.

3-3604. Gray, Carlyle, and Davis M. Lapham. **GUIDE TO THE GEOLOGY OF CORNWALL, PENNSYLVANIA: Pennsylvania, Geol. Survey, Bull. G35, 18 p., 5 figs., geol. map and secs. (in pocket), 1961, 10 refs.**

Cornwall, Pennsylvania, is a well-known mining locality which is of interest from historical, economic, and geologic viewpoints. The history of the magnetite mining operations from 1742 to 1960 is briefly reviewed. The ore is spatially and genetically associated with a Triassic diabase sheet which is intrusive into folded and faulted, lower Paleozoic limestones. Clastic Triassic sediments unconformably overlie the limestones. The ore replaces beds of the Buffalo Springs member, the oldest of 5 Cambrian units mapped in the area. The magnetite ore is associated with chalcopyrite, pyrite, earlier amphiboles, and pyroxenes, and later silicates such as mica, chlorite, and zeolites. Both the structure and the mineralogy of the ore deposit indicate that it is genetically related to the diabase, although somewhat later in time than the crystallization of the diabase. --Auth.

3-3605. Timofeev, P. P. SOME DISTINCTIVE FEATURES IN THE GEOLOGIC DEVELOPMENT OF TUVA DURING THE MIDDLE AND LATE PALEOZOIC AND THE MESOZOIC: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 502-504, May-June 1959, pub. 1960, 12 refs.

The Paleozoic rocks of Tuva may be divided into 5 structural stages: 1) Cambrian basement, 2) Ordovician, 3) Silurian and Devonian, 4) Carboniferous, and 5) Middle Jurassic and Late Jurassic-Early Cretaceous deposits of the Bom series. The main body of the structural depression includes Silurian, Devonian, and Carboniferous rocks, following which a long period of erosion occurred in Permian to early Jurassic time. Following the coal-bearing Jurassic-Cretaceous series the area was uplifted, maximum movement occurring in Quaternary time.--F. Manheim.

3-3606. Lutts, B. G. STRATIGRAPHY AND TECTONICS OF THE SOUTHERN PART OF THE ANABAR MASSIF: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 515-517, map, May-June 1959, pub. 1960, 2 refs.

The investigated massif consists of an Archean supracrystalline complex which has undergone intense regional metamorphism. The main mass has the characteristic features of a paragneissic complex such as schistosity of the different gneisses and their conformable interstratification with quartzites, marbles, and calciphyres. It was possible to establish that the major part of the basic crystalline schists and amphibolites was a product of Archean volcanism.

Permian-Triassic tectonic activity, which affected the whole of the Siberian platform, is reflected in the massif by numerous narrow diabasic dikes having a NE. strike.--F. Manheim.

2. GEOMORPHOLOGY

See also: Areal and Regional Geology 3-3594, 3-3595, 3-3596, 3-3599; Structural Geology 3-3637; Engineering Geology 3-3914.

3-3607. Shumsky, P. A. THE DENSITY OF GLACIER ICE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 558-560, 2 figs., May-June 1959, pub. 1960.

Glacial ice contains significant quantities of occluded air. As new ice is accumulated and the older ice sinks, the ice is compressed and becomes denser. Conversely, in areas of melting surface ice, or as ice returns to the surface it partly expands and becomes less dense. A mathematical analysis of ice density in glaciers is presented, and the parameters of interest are expressed in terms of pressure and depth.--F. Manheim.

3-3608. Sigafoos, Robert S., and E. L. Hendricks. BOTANICAL EVIDENCE OF THE MODERN HISTORY OF NISQUALLY GLACIER, WASHINGTON: U. S. Geol. Survey, Prof. Paper 387-A, 20 p., 15 figs., 1961, 25 refs.

A knowledge of the areas once occupied by mountain glaciers reveals at least part of the past behavior of these glaciers. From this behavior, inferences of past climate can be drawn. The maximum advance of Nisqually Glacier in the last thousand years was located, and retreat from this point is believed to have started about 1840. The maximum downvalley position of the glacier is marked by either a prominent moraine or by a line of difference between stands of trees of strikingly different size and significantly different age. The thousand-year age of the forest beyond the moraine or line between abutting stands represents the minimum time since the surface was glaciated. This age is based on the age of the oldest trees, plus an estimated interval required for the formation of humus, plus evidence of an ancient fire, plus an interval of deposition of pyroclastics. The estimate of the date when Nisqually Glacier began to retreat from its maximum advance is based upon the ages of the oldest trees plus an interval of 5 years estimated as the time required for the establishment of trees on stable moraines. This interval was derived from a study of the ages of trees growing at locations of known past positions of the glacier.

Reconnaissance studies were made on moraines formed by Emmons and Tahoma glaciers. Preliminary analyses of these data suggest that Emmons Glacier started to recede from its maximum advance in about 1745. Two other upvalley moraines mark positions from which recession started about 1849 and 1896. Ages of trees near Tahoma Glacier indicate that it started to recede from its position of maximum advance in about 1635. About 1835 Tahoma Glacier started to recede again from another moraine formed by a readvance that terminated near the 1635 position.--Auth.

3-3609. Sullivan, Walter. POLAR PENINSULA WORLD'S LONGEST: New York Times, v. 110, no. 37,836, p. 79, col. 1-4, map, Aug. 27, 1961.

The Filchner ice shelf, Antarctica, extends inland as far as the Sentinel Range on the basis of photogrammetric analysis by the U. S. Geological Survey. This increases the known length of the Antarctic Peninsula (Palmer Peninsula), a structural continuation of the Andes, to 1,200 mi., and the extent of the Filchner ice shelf to 330,000 sq. km.--M. Russell.

3-3610. Schneider, Allan F. PLEISTOCENE GEOLOGY OF THE RANDALL REGION, CENTRAL MINNESOTA: Minnesota Geol. Survey, Bull. 40, 151p., 31 figs., col. geol. map (in pocket), scale 1:62,500, 11 tables, 1961, 63 refs.

During the Cary subage of the Wisconsin glacial age, central Minnesota was invaded by ice from several directions, as indicated by diagnostic landforms and by tills of distinctive lithology. Many of the significant stratigraphic and geomorphic relationships attesting to the complex Cary history of central Minnesota occur in and near the Randall region, immediately W. of the Mississippi River in western Morrison and eastern Todd counties. The surficial geology and Pleistocene history of this area are described in detail and significant regional relations are reviewed.

Four ice lobes of Cary age are recognized: 1) the Wadena lobe, which deposited calcareous gray (yellowish-brown where oxidized) sandy till derived largely from the Paleozoic limestone terrane of southern Manitoba; 2) the Superior lobe, which deposited red sandy till acquired by passage over upper Keweenawan red sandstone of eastern Minnesota; 3, 4) the Pierz and Brainerd lobes, which brought noncalcareous brown sandy till derived from dark-colored Precambrian crystalline rocks of northeastern Minnesota. Field and laboratory data concerning the lithologic characteristics of these drifts are discussed in detail.

The Wadena lobe entered central Minnesota from the NE., spread radially to the S. and W. to form the fan-shaped Wadena drumlin field of Wadena and Todd counties, and probably terminated at the Altamont-Gary moraine. It entered the Randall region from the NW. and advanced eastward across the Mississippi River. As the Wadena lobe withdrew, the Superior lobe from the Lake Superior basin pushed westward and probably reached its terminus about 15 mi. W. of Little Falls. Interbedding and reverse superposition of gray and red drifts suggest that the lobes were locally concurrent.

The Pierz lobe entered central Minnesota from the E., radiating westward to form the fan-shaped Pierz drumlin field of eastern Morrison and Benton counties. As the ice penetrated northwestward into the Randall region, it encountered the retreating Wadena lobe, so that its noncalcareous brown till not only overlies but is also interbedded with calcareous gray Wadena-lobe drift. The terminus of the Pierz lobe is represented generally by an arcuate segment of the St. Croix moraine S. of Pillager gap, but extramorainic brown till indicates that a tongue of Pierz ice extended farther NW.

Pierz-lobe meltwater deposited an extensive outwash plain W. of the moraine along the Long Prairie and Crow Wing rivers. Leverett believed that this plain was deposited in glacial Lake Wadena, which drained to the S. As the Pierz lobe retreated eastward, the meltwater found additional routes of southward escape around the western edge of the ice; this resulted in the development of an anastomotic spillway system along the inner margin of the moraine.

By this time the Brainerd lobe from the NE. had fashioned the Brainerd drumlin field of southern Crow Wing County. E. of the Mississippi River part of its southern terminus is represented by the Nakasippi moraine. W. of the river the ice pushed southwestward to Cushing, obliquely overriding part of the St. Croix moraine that had just been built by the Pierz lobe.

Accelerated retreat of the Pierz and Brainerd lobes at the close of the Cary subage resulted in the formation of the Green Prairie terrace by the newly established Mississippi River. N. of Fort Ripley the terrace grades into a pitted outwash plain, which was deposited as the Brainerd lobe retreated northward. This retreat opened Pillager gap, permitting the eastward drainage of Lake Wadena and thus the reversal of the Long Prairie River, its former outlet. During the Mankato and Valders subages, central Minnesota was not reglaciated, and the course of the Mississippi River between Brainerd and St. Cloud remained open. --Auth.

3-3611. Orlov, V.I. **ON THE MAXIMUM QUATERNARY GLACIATION OF THE WEST SIBERIAN LOWLAND:** Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 449-451, map, May-June 1959, pub. 1960, 12 refs.

Studies of the present day landforms and surface deposits have outlined the main extension of the Quaternary glaciation in the W. Siberian lowland. The southern boundary of the glaciation extends from S. of Serov, SE. through the Tara region, and eastward to the Chulym river. In the Ob-Yenisey interfluve the boundary must be placed farther S. than previously considered.--F. Manheim.

3-3612. Savelev, B.A. **PECULIARITIES OF THE ICE-THAWING PROCESS OF THE ICE COVER AND IN FROZEN GROUND:** Problems of the North - Problemy Severa, in translation, no. 1, p. 160-167, 2 figs., 1958, pub. 1960, 16 refs.

The mathematical relations of various factors in the thawing process in permafrost areas are reviewed. The effect of such factors as size of ice lenses, insulating effect of ice layers, and salinity of the soil and water are considered. The mineral content of the soil and ice in thawing ground gives rise to physico-chemical effects on the thawing process which are difficult to evaluate.--M. Russell.

3-3613. Corte, Arturo E. **EXPERIMENTAL FORMATION OF SORTED PATTERNS IN GRAVEL OVERLYING A MELTING ICE SURFACE:** Biuletyn Peryglacjalny, no. 8, p. 65-72, 1960.

Varying thicknesses of nonfrost-susceptible gravel spread on glacier ice near Thule, Greenland, produced differential melting of underlying ice during the summer of 1957. A cover of 5 cm. allowed more rapid melting than one of 15 cm., with the resultant formation of mounds and depressions. Coarse fragments set in motion by the collapse of the gravel cover were concentrated mechanically into the depressions. Stone rings were produced where the gravel varied in thickness, and a poorly developed stone stripe was formed in a meltwater channel. It is considered that natural patterns on the edge of the ice cap are similarly initiated by differential melting under a gravel cover of variable thickness, and that mechanical sorting produced by differential collapse of newly thawed permafrost initiates the formation of sorted patterns in outwash material from which the active layer has been removed.--R. S. Waters (courtesy Geomorphological Abstracts, no. 4, p. 28, March 1961).

3-3614. Holmes, Chauncey D., and Roger B. Colton. **PATTERNED GROUND NEAR DUNDAS (THULE AIR BASE), GREENLAND:** Meddelelser om Grønland, v. 158, no. 6, 15 p., 1960.

A short paper presenting the results of work carried out in NW. Greenland. The authors draw attention to the varying forms of patterned ground found developed on differing forms of glacial drift. The type of patterned ground formed depends on 3 factors: 1) the nature of the drift, 2) the conditions of the subsurface drainage, and 3) the angle of slope. A diagram is included which outlines in a generalized manner the type of patterned ground to be expected with varying relationships of these factors. The origin of the fractures outlining polygonal features are explained as due to the contraction of the frozen surface deposits. The sorting exhibited by some of the polygonal forms (postdating the fracturing) is tentatively suggested as due to Washburn's "cryostatic hypothesis."--D. Ingle Smith (courtesy Geomorphological Abstracts, no. 4, p. 32, March 1961).

3-3615. McBeth, Frank H. AERIAL PHOTOGRAPHIC INVESTIGATION OF LEACHING AND SAPPING AS AN EROSION PROCESS: Photogrammetric Eng., v. 27, no. 1, p. 154-155, March 1961.

The hypothesis is suggested that the majority of slopes found in humid-tropical areas are the result of leaching and sapping processes.--J. R. Van Lopik.

3-3616. Beaty, Chester B. BOULDER DEPOSIT IN FLINT CREEK VALLEY, WESTERN MONTANA: Geol. Soc. America, Bull., v. 72, no. 7, p. 1015-1020, 2 maps, July 1961, 14 refs.

Morphologic evidence in an unusual boulder field in the Flint Creek valley of western Montana, previously classified as glacial moraine, suggests a debris flow deposit carried from Boulder Creek, a tributary of Flint Creek. A large flood from a cloudburst in the headwaters of Boulder Creek or a moraine-dammed lake in a cirque in the upper stream system surged down the main Boulder Creek valley, picking up glacial debris and depositing it in lobate form in the Flint Creek valley. Other boulder deposits in western Montana and elsewhere with similar morphologic characteristics may also be of fluvial, rather than glacial, origin.--Auth.

3-3617. Finkel, Herman J. THE MOVEMENT OF BARCHAN DUNES MEASURED BY AERIAL PHOTOGRAMMETRY: Photogramm. Eng., v. 27, no. 3, p. 439-444, 5 figs., 2 tables, June 1961, 2 refs.

Field measurement of 45 barchan dunes of the Pampa de La Joya, Peru, indicated the following linear relationship between width (W) and crest height (H), in meters: $W = 10.3H + 4.0$. The width (W) is measured across the horns of the dune at right angles to the wind direction. Various factors, including annual displacement or movement of dunes exhibiting different crest heights, were determined by employing photogrammetric techniques. Annual displacement ranged from approximately 30 m., for dunes with crest heights of 1 m., to 9 m. of displacement for 7-m. dunes.

Greater concentrations of barchans were noted toward the upwind end of the study area and average distribution density decreased downwind. The decrease in dune density downwind appeared to be the result, primarily, of the lateral spreading of approximately the same number of barchans over a progressively wider area. If a mathematical analysis of the size-distribution of barchans over the entire area is made, it may be possible to calculate the minimum period of time required for the achievement of the present configuration. This would permit the dating of climatic changes in post-Quaternary time.--J. R. Van Lopik.

3-3618. Chenoweth, William L., and Maurice E. Cooley. PLEISTOCENE CINDER DUNES NEAR CAMERON, ARIZONA: Plateau, v. 33, no. 1, p. 14-16, sec., July 1960.

U mining operations 11 1/2 mi. SE. of Cameron, Arizona, on the W. side of the Little Colorado River have encountered a 5 to 10 ft. thick bed of black, cross-bedded, medium- to coarse-grained, basaltic cinders. The cinders lie on terrace gravels, which were deposited on a well-defined erosional surface in the Cameron-Black Point area. The cinders are overlaid by a slump of U ore-bearing sandstone from the Petrified Forest member of the Chinle formation.

The terrace on which the gravel and cinders occur is part of the middle terrace of the Wupatki erosion surface. Field relationships indicate that the slumpage at the U mining area took place after the middle Wupatki terrace, but before or contemporaneous with the later Wupatki terraces. The cinder dunes were deposited during the same time, as they have been preserved by the slumpage. From the relationships with the Wupatki erosion surfaces, the dunes were formed about late middle or early late Pleistocene time. This is probably the oldest known occurrence of Pleistocene cinder dunes related to the San Francisco volcanic field.--F. R. Hall.

3-3619. Bigarella, João José, and Riad Salamuni. EARLY MESOZOIC WIND PATTERNS AS SUGGESTED BY JUNE BEDDING IN THE BOTUCATÚ SANDSTONE OF BRAZIL AND URUGUAY: Geol. Soc. America, Bull., v. 72, no. 7, p. 1089-1105, 8 figs., 6 tables, July 1961, 24 refs.

At 51 outcrops of the eolian Botucatú sandstone (early Mesozoic) in Brazil and Uruguay the writers made 2,892 measurements. A new instrument for making these measurements has been designed and constructed and is thought to provide accurate data more rapidly than present methods.

Two wind trends have been detected in the Botucatú sandstone. The southern outcrops indicate deposition by winds which blew mainly from the W. or WSW.; the northern outcrops indicate deposition by a prevailing wind blowing from the N. or NNE.

Orientation of cross-bedding in the Botucatú sandstone suggests that most of this sand was deposited in the trade-wind belt, on the assumption that the wind belts have been a general feature throughout geological time. In some respects, the position of present-day high- and low-pressure areas in South America and vicinity are believed comparable to those existing in Triassic time. Early Mesozoic wind patterns and pressure belts, as determined from eolian cross-bedding dip directions, are in agreement with the paleomagnetic results reported by Creer.--Auth.

3-3620. Bunting, B. T. THE ROLE OF SEEPAGE MOISTURE IN SOIL FORMATION, SLOPE DEVELOPMENT, AND STREAM INITIATION: Am. Jour. Sci., v. 259, no. 7, p. 503-518, 7 figs., 4 pls., 2 tables, Summer 1961, 14 refs.

Field study of the podsolized soils and the drainage of an escarpment of Chatsworth gritstone (upper Namurian) in northern England has suggested hypotheses relating to stream initiation and crestal development.

Moisture moving from crests over dip slopes of less than 5° becomes concentrated in narrow lines of relatively deep soil of distinctive phase. These lines are termed "seepage lines" and form a dendritic pattern linked directly to visible drainage lines. Colluvium has gathered in certain depressions at the head of visible scarp and dip streams, and corrosion of the underlying bedrock, by accumulated seepage moisture, is taking place at depth. This corrosion of bedrock in seepage hollows is considered to be a major factor in the headward extension of first-order streams.

Moisture accumulation on crestal areas is limited so that corrosion and soil formation take place but slowly, or not at all, at least under present conditions. A crestal rock platform is thus preserved, with rock bastions or "tors" located upon it, the heights of which represent the thickness of material removed from the adjacent slopes by a combination of periglacial mass-wasting and postglacial surface and subsurface denudation.

Detailed studies of the soil mantle on such low-angle slopes on a uniform bedrock material have failed to establish any simple relationship of soil depth, profile, or texture with degree of slope or facet type. Position on the total slope in relation to the seepage net and indirectly to the drainage net is the most significant factor in soil formation and hence in slope development and denudation.--Auth.

3-3621. Wascher, Herman L., and others. CHARACTERISTICS OF SOILS ASSOCIATED WITH GLACIAL TILLS IN NORTHEASTERN ILLINOIS: Illinois, Agr. Expt. Sta., Bull. 665, 155p., 28 figs., col. map (in pocket), 2 col. pls., 8 tables (1 in pocket), Nov. 1960, 80 refs.

Data from physical, chemical, and mineralogical analyses and field studies are used to characterize 33 representative soil profiles of 17 different soil series from 3 great soil groups — gray-brown podzolic, brunizem (prairie), and humic-gley.

Because of the important role glacial till plays in the identification and classification of the soils, considerable information is presented characterizing the kinds of glacial till in northeastern Illinois. Different kinds of till result in differences in the morphology of the soil profiles — the key to proper soil classification in this area.

The colored map shows location and extent of areas of soils associated with loamy gravel, sandy loam, and silt loam, silty clay loam, silty clay, and clay textures of till. This map also shows areas of soils developed from medium- and fine-textured water-deposited sediments as well as wind- and water-deposited sandy materials.--From auth.

3-3622. Jordan, G. F., and Harris B. Stewart, Jr. SUBMARINE TOPOGRAPHY OF THE WESTERN STRAITS OF FLORIDA: Geol. Soc. America, Bull., v. 72, no. 7, p. 1051-1058, 5 figs., 3 pls., July 1961, 22 refs.

Recently completed hydrographic surveys by the U. S. Coast and Geodetic Survey cover an area of about 7,000 sq. nautical mi. S. of the outer Florida Keys. Details of the topography of the continental slope that do not appear on published nautical charts are given. The principal features are 1) a swarm of valleys incising the slope S. of Dry Tortugas, 2) an elongate terrace terminating to the W. in an area of undulating bottom, and 3) 2 prominent escarpments and several minor slope breaks.

The valleys are believed to be related to 2 separate periods of valley formation. Straight downslope trends and leveed sides suggest turbidity-current action in at least some of the valleys. The escarpments are interpreted as having a fault origin, and the area of undulating bottom is believed to be a set of step faults related to the larger Pourtales escarpment. --Auth.

3-3623. Krause, Dale C. GEOLOGY OF THE SEA FLOOR EAST OF GUADALUPE ISLAND: Deep-Sea Research, v. 8, no. 1, p. 28-38, 12 figs., June 1961, 17 refs.

A gently rolling surface of very soft folded sediment lies at the anomalously shallow deep-sea depth of 1,900 fathoms E. of Guadalupe Island, NE. Pacific. Sub-bottom echoes occur at a uniform depth of 6-8 m. over most of the area, and photographs reveal organisms vigorously reworking much of the upper 10 cm. of sediment. At present, the region is surrounded by a deeper sea floor and cannot receive bottom-transported sediment. The origin of this anticlinorium is indeterminate. Geomagnetic profiles reveal N.-S. anomalies which are typical of the oceanic crust of the northeastern Pacific Ocean basin and which parallel the folds though are not necessarily related to them. Large tectonic features surround the area such as volcanoes, ridges, basins, and deeps. Compared to these features, it is relatively deformed and appears to have a normal oceanic crust because it has 1) a long depositional history, 2) N.-S. magnetic anomalies, and 3) a normal thickness.--Auth.

3-3624. Bird, J. Brian, and M. B. Bird. BATHURST INLET, NORTHWEST TERRITORIES: Canada, Dept. Mines & Tech. Surveys, Geog. Branch, Mem. 7, 66 p., 11 illus., 9 maps (4 in pocket), 2 tables, 1961, 12 refs.

Bathurst Inlet is a complex submerged valley that penetrates from the E. end of Coronation Gulf in a southeasterly direction for 120 mi. into the heart of the barren grounds. Although located entirely within the Canadian Shield, the landscape does not have the monotony of many parts of the Shield. The varied scenery is due to the presence of many rock types, such as, in the northern part, dolomite, basalt, and diabase of the Coppermine series. Within the inlet there are drift-covered lowlands, often crossed by striking cuestas. On either side, the uplands of the Shield rise in vertical walls, in places over 1,400 ft. high, broken only by the gorges of the rivers.

The first half of the memoir discusses the physical background of the area, with sections on: geology, preglacial evolution of the landscape, origin of Bathurst Inlet, glaciation, postglacial emergence, and surface deposits and their economic importance. The regional physical geography of the 2 major regions of the Mackenzie uplands and the Coronation Lowlands is then considered, followed by sections on climate, ice conditions, vegetation, wild life, and human geography.--F. A. Cook.

3-3625. von Engeln, O. D. THE FINGER LAKES REGION: ITS ORIGIN AND NATURE: 156 p., illus., maps, diags., Ithaca, New York, Cornell University Press, 1961, 11 refs.

A regional geomorphological study written for the layman and for the scientific reader. The prologue gives a brief geomorphic history of the region. Then follow chapters on escarpments and cuestas, the peneplain uplands and their dissection, Finger Lakes "East" and Finger Lakes "West," glacial erosion and rock-basin lakes, hanging valleys and through valleys, rock gorges and two glacial advances, the high-level Finger Lakes, and glacial deposits. An epilogue deals with the causes of ice ages. One appendix lists vantage points and excursions and another deals with available maps. A glossary and brief list of references are also given.--A. C. Sangree.

3. STRUCTURAL GEOLOGY

See also: Geophysics 3-3683, 3-3684, 3-3692, 3-3722, 3-3727, 3-3737, 3-3749, 3-3750; Igneous and Metamorphic Petrology 3-3831; Mineral Deposits 3-3874.

3-3626. Mirchink, M. F., and V. P. Bukhartsev. THE POSSIBILITY OF STATISTICAL STUDIES OF STRUCTURAL RELATIONS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v.126, no. 1-6, p. 495-497, fig., May-June 1959, pub. 1960, 4 refs.

The principles of statistical comparison of 2 structural surfaces are discussed. Any structural surface may be designated by the distribution of its absolute elevations. Study of the structural relations then reduces to a statistical correlation of such distributions. In most cases there is linear correlation and the relationship between 2 structural surfaces may be given by:

$$r = \frac{\Sigma (x-\bar{x})(y-\bar{y})}{n\sigma_x \sigma_y}$$

where r is the coefficient of linear correlations, x and y are the depths of the 2 structural surfaces at points along a single vertical line, n is the number of observations and σx and σy are the standard deviations from the mean values, $\bar{x}$ and $\bar{y}$.--F. Manheim.

3-3627. Brace, William F. MOHR CONSTRUCTION IN THE ANALYSIS OF LARGE GEOLOGIC STRAIN: Geol. Soc. America, Bull., v. 72, no. 7, p.1059-1079, 15 figs., July 1961, 26 refs.

A semigraphical method of analysis of large strain based on Nadai's strain components and utilizing a Mohr construction is outlined for problems of interest in structural geology. Finite homogeneous strain theory is applicable to measurement and analysis of strains from geologic features small enough to be included within regions of homogeneous strain. Use of this theory and of the strain ellipsoid and its properties implies nothing about isotropy or homogeneity of the rocks or about the stress-strain relation during deformation, and therefore its application is valid over a much wider range of phenomena than most geologists realize.

Strain can be measured, and under favorable conditions the principal strain axes can be determined, by using not only the familiar ooids, pebbles, and crinoid columnals but also a large group of fossil remains and impressions and primary sedimentary structures. The most useful features are single linear elements in which extension can be measured; the next most useful are groups of 3 directions of known original relative orientation, and the least useful are originally perpendicular line elements. Under ideal and unusual conditions volume change can be measured.

Examples of strain analysis are worked out in detail to illustrate both the versatility and limitations of the method.--Auth.

3-3628. Roberts, J. C. FEATHER-FRACTURE, AND THE MECHANICS OF ROCK-JOINTING: Am. Jour. Sci., v. 259, no. 7, p. 481-492, fig., 2 pls., Summer 1961, 12 refs.

Joint plane studies in the South Wales coalfield reveal distinctive featherlike fracture patterns on the majority of shear joint surfaces. The pattern includes an axis, plumes or barbs diverging from the axis, and a border or fringe composed of 2 sets of intersecting fracture planes. Feather-fracture occurs most frequently on shear joint surfaces in fairly fine-grained rocks and is here described from rocks of varying lithologies, ranging in age from Devonian to Jurassic.

Recent experimental work suggests that the "cleavage fracture" of mild steel, which is characterized by the development of a herringbone pattern, is analogous to that of feather-fracture in rocks. Such "cleavage fracture" is characteristic of brittle failure, produces no distortion, and requires expenditure of only small amounts of energy.

Joints displaying feather-fracture may have formed similarly. The feather patterns on shear joints indicate that the main direction of movement was normal, not parallel, to the joint plane, while areas of feather divergence may be used to locate the positions of the initial fractures that controlled subsequent joint development. From a detailed study of the areas of feather divergence, it is therefore possible to attempt a reconstruction of the actual centers of initial fracture.--Auth.

3-3629. Lattman, Laurence H., and Richard H. Matzke. GEOLOGICAL SIGNIFICANCE OF FRACTURE TRACES: Photogramm. Eng., v. 27, no. 3, p. 435-438, 2 illus., June 1961, 8 refs.

Fracture traces, as now mapped in a variety of landscapes, are parallel or subparallel to joints in areas of flat or very gently folded rocks but are not parallel to the dominant joint sets in folded rocks. They apparently extend downward to depths of at least 3,000 ft. at Bisbee, Arizona, where ore pods, which are fracture-controlled, are parallel to surface fracture traces. A probable wrench fault in Alaska separates 2 areas of different fracture-trace orientations, but fracture-trace orientations are identical on both sides of a thrust fault in central Pennsylvania. Extrusive and intrusive igneous rocks in the same area of Alaska show different fracture-trace orientation.--Auth.

3-3630. Hodgson, Robert A. CLASSIFICATION OF STRUCTURES ON JOINT SURFACES: Am. Jour. Sci., v. 259, no. 7, p. 493-502, 8 figs., Summer 1961, 7 refs.

Joint faces commonly show certain structural features such as plumelike markings and fringe joints. The description and classification of these and other peripheral or subordinate structures is useful in providing a material aid to their recognition, and is thus a necessary prerequisite to any discussion of the genesis of joints. The first detailed description and classification was presented by J. B. Woodworth in 1896. More recent study of these structures has provided additional information and makes it desirable to extend and modify this classification. The revised classification recognizes significant subdivisions of the term "joint" and treats additional structural features not discussed by Woodworth or shown in his classification. It is obvious from a consideration of the morphology of joint surface structures that any transcurrent movement along the joint face at the time of generation of the fracture cannot occur without destroying or greatly modifying the surface structure.--Auth.

3-3631. Beloussov, V. V. THE ORIGIN OF FOLDING IN THE EARTH'S CRUST: Jour. Geophys. Research, v. 66, no. 7, p. 2241-2254, 14 figs., July 1961, 32 refs.

In the light of recent special study, folding phenomena represent the reaction of the layered beds of the earth's crust on the differential vertical movement of separate blocks of the crust. It is possible to distinguish the following types of folding. Block folding represents the most direct reaction of layers on the vertical movements of the crust's blocks, the most characteristic of this type of folding being boxlike folds. They occur both on platforms and in geosynclines. Injection folding is due to the horizontal flow of the more plastic rocks, which are squeezed out from some areas and accumulate in others, where injection or piercement cores are formed. The flow of plastic rocks results from the uneven load of superimposed layers and especially from the fractures that cut these layers. The main places of occurrence of injection folding are foredeeps and tectonic basins. Metamorphic or deep folding is connected with the processes of granitization and metamorphism when the density of rocks becomes lower as the result of the impregnation of rocks by volatile substances. Reduced density induces upward flow, as a result of which deep diapirlike structures are formed. The folding of general crumpling mostly represents the influence of gravitational forces provoking the sliding of layers down the slopes or the spreading out of the upper parts of the elevated blocks. Such spreading out creates horizontal compressive forces which crumple the adjacent layers into folds. Sometimes the folding of general crumpling is created by the pushing apart under the mechanical influence of injection cores or of deep metamorphic diapirlike structures. The deep folding and the folding of general crumpling occur widely in geosynclinal belts. There are no indications in the phenomena of folding of the existence of general compressional forces in the earth's crust. Horizontal compression exists only as a local phenomenon and is limited to some narrow belts within geosynclines. The causes of horizontal compression are also local. Only vertical movements of separate blocks of the crust exist as primary phenomena. --Auth.

3-3632. Shvarts, T. V. TECTONIC DEVELOPMENT OF THE KUM-DAG FOLD IN THE LATE PLIOCENE: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 5-A, p. 287-293, 3 figs., table, 1959, pub. 1961, 3 refs.

The irregular growth of an anticline in SW. Turkmenia, complicated by a central graben along its crest, during the Pliocene and Quaternary periods is described. Movements took place while sedimentation continued. They were most intensive during the Quaternary, when the growth of the anticline was at a rate of 2 cm. per 100 years and sedimentation at a rate of 1,280 m. per 1 million years, as compared with an average sedimentation during the entire Pliocene-post-Pliocene time of 375 m. per 1 million years.--C. Voûte.

3-3633. Chekunov, A. V. SOME REGULARITIES IN THE DEVELOPMENT OF THE CRIMEA-CAUCASUS ANTERIOR DOWNWARP: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 458-460, May-June 1959, pub. 1960, 10 refs.

The Crimea and Great Caucasus geosynclines developed separately and at different times. The influence of the Crimean geosyncline on the larger downwarp was prominent during the Mesozoic, while the Caucasus dominated during Paleocene to Quaternary time. The zones of maximum sinking alternated between these 2 areas and were characterized by great amplitudes, particularly in the southern part of the structure.--F. Manheim.

3-3634. Swingle, George D. STRUCTURAL GEOLOGY ALONG THE EASTERN CUMBERLAND ESCARPMENT, TENNESSEE: Tennessee, Div. Geology, Rept. Inv. no. 13, 46 p., 8 figs., geol. map (in pocket, scale 1:125,000), 1961, 27 refs.

Structural relationships between Pennsylvanian rocks of the Cumberland Plateau and earlier Paleozoic rocks of the Valley and Ridge are summarized along a 50-mi. strip between Dayton and Harriman. Discussion is based on detailed (1:24,000) mapping of nine 7 1/2 min. quadrangles.

A previously unrecognized major thrust fault is described. Large blocks of Pennsylvanian rocks lying amidst Valley and Ridge strata are interpreted as windows related to this fault. The Cumberland escarpment is structurally high, probably owing to a buried low-angle thrust. Mechanics of deformation of adjacent Valley and Ridge rocks is quite similar to that previously ascribed to Cumberland Plateau strata. The structures of each of the provinces coalesce, and there is no sharp structural break between them as suggested by the present erosional escarpment.

This report was used as the guidebook for a field trip conducted in conjunction with the 1961 meeting of the Southeastern Section of the Geological Society of America, and it includes road logs and stop descriptions.--Auth.

3-3635. Kudrin, L. N. THE TECTONIC FEATURES OF THE NORTHEASTERN PART OF THE UPPER TISZA DEPRESSION (TRANS-CARPATHIA): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 443-445, May-June 1959, pub. 1960, 9 refs.

Detailed geological and structural investigation of the upper Tisza depression has been carried out. A flexurelike subsidence is found along the northern and northeastern margin of the depression. To the S. and SW. of the flexurelike subsidence are found 2 en echelon synclines, the Ternovskaya and the Ganichi, with the small Stremenus anticline between them. The northern, northeastern, and northwestern parts of the Tisza depression underwent uplift at the end of the Pliocene-Pleistocene, while the southwestern parts were depressed. Maximum aplitude of depression in the Quaternary was 700 m.--F. Manheim.

3-3636. Gofshtein, I. D. THE RANGE OF RECENT TECTONIC MOVEMENTS IN THE DNESTR REGION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 424-426, 2 figs., May-June 1959, pub. 1960, 6 refs.

Studies of the Dnestr terraces in the N. Bukovina region have shed light on the tectonic movements during the Quaternary period. The range of local uplift since the commencement of the Quaternary is 335 m., 300 m. of this movement having occurred during Eopleistocene time.--F. Manheim.

3-3637. Gorelov, S. K. SOME LAWS GOVERNING THE RECENT TECTONICS OF LOCAL STRUCTURES OF THE VOLGA REGION AND THE NORTH CAUCASUS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 421-423, map, May-June 1959, pub. 1960, 7 refs.

A combined geological-geomorphological method was used to analyze the relationship of tectonics to local features such as the type of relief, drainage, and thickness and lithofacies of the Quaternary deposits of the Volga region and the N. Caucasus. The local uplifts and depressions were divided into 3 groups, active structures corresponding to buried domes in the crystalline basement, weakly active structures, and inactive structures. Both of the latter are referred to depressions or flanks of large substructural prominences.--F. Manheim.

3-3638. Rikhter, V. G. SOME FEATURES OF THE RECENT TECTONISM OF THE CASPIAN SEA DEPRESSION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 452-454, fig., table, May-June 1959, pub. 1960, 2 refs.

By correction of tide gauge data for hydrometeorological features, average annual tectonic movements for various locations in the Caspian area have been calculated. In the epi-Hercynian Transcaspian platform a general uplift is noted after 1940, while on the western shore of the Caspian and in the northern slope region of Elburz, systematic depressions are recorded. The SW. Caucasus region is characterized by both uplift and differential sinking. It may be noted that the Baku region is not a reliable guide for the Caspian as a whole because of the intense and erratic tectonic movements there.--F. Manheim.

3-3639. Varentsov, M. I., and V. I. Ditmar. THE FORMATION OF THE TENGIZ AND KARAGANDA BASINS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 465-467, May-June 1959, pub. 1960, 6 refs.

The Tengiz and Karaganda basins of central Kazakhstan are somewhat elongated intermontane basin types. These basins show the effects of 3 epochs of geotectonic development. The Caledonian epoch of folding produced a far-reaching system of anticlinoria in the entire region. The Hercynian tectogenic cycle superimposed a system of broad, gentle synclines and anticlines on the preexisting structure. The following Alpine folding cycle is first expressed in marked unconformity followed by warping and finally subsidence which continued into the Quaternary.--F. Manheim.

3-3640. Musatov, D. I., and A. P. Tarkov. THE PROBLEM OF THE TECTONIC STRUCTURE OF THE CENTRAL PART OF THE SAYAN-ALTAI FOLDED REGION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v.126, no. 1-6, p. 520-523, map, May-June 1959, pub. 1960, 3 refs.

A subdivision of the Caledonian folded structures of the Kuznetsk Alatav, the N. face of W. Sayan, the western part of E. Sayan, and the substructure of the Minusinsk intermontane depressions has been carried out on the basis of geologic data and aeromagnetic surveys. The basic structural elements in the tectonic system include basement prominences consisting of Proterozoic gneisses, schists, and amphibolites, geosynclinal troughs accompanying deep faults, less thick geosynclinal depressions and uplifts within the geosynclines. In addition, faults and intrusive complexes of various ages are present. The regional distribution of these elements is discussed.--F. Manheim.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 3-3587, 3-3589, 3-3590, 3-3591, 3-3600; Paleontology 3-3662; Mineralogy 3-3820; Igneous and Metamorphic Petrology 3-3824, 3-3833; Sedimentary Petrology 3-3836 through 3-3839; Fuels 3-3895.

3-3641. Hedberg, Hollis D. STRATIGRAPHIC CLASSIFICATION OF COALS AND COAL-BEARING SEDIMENTS: Geol. Soc. America, Bull., v. 72, no. 7, p. 1081-1088, 2 figs., July 1961, 2 refs.

Coal beds are normal lithologic components of numerous stratigraphic sequences of sedimentary rock and therefore should be amenable to the same basic principles of lithostratigraphic classification and terminology as other common sedimentary-rock types. However, because of the distinctive lithologic character of coal and its commercial value, the individual bed of coal is particularly important and serves to point up the role of bed as a formal lithostratigraphic unit. Sequences of several distinct but associated coal beds may constitute the basis for unification of strata into larger, formally named, coal-bearing lithostratigraphic units of the rank of member, formation, or group.

The general principles of lithostratigraphic classification and terminology are reviewed with particular reference to coals and coal-bearing strata, and hypothetical situations are diagrammatically illustrated to show the application of these principles.--Auth.

3-3642. Miroshnikov, L. D., and others. THE STRATIGRAPHICAL SEQUENCE OF THE LOWER AND MIDDLE PALEOZOIC OF THE NORTHWESTERN MARGIN OF THE SIBERIAN PLATFORM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 446-448, May-June 1959, pub. 1960, 4 refs.

Detailed stratigraphic and paleontologic studies of pre-Tunguska sediments in the Norilsk region have made possible the dating of the sequence and correlation with the North American Cambrian equivalents. The highly carbonatic sequence ranges from Middle Cambrian to the Tournaisian stage of the lower Carboniferous, above which lie the continental Tunguska series.--F. Manheim.

3-3643. Oder, Charles R. L., and James G. Bumgarner. STROMATOLITIC BIOHERMS IN THE MAYNARDVILLE (UPPER CAMBRIAN) LIMESTONE, TENNESSEE: Geol. Soc. America, Bull., v. 72, no. 7, p. 1021-1028, 2 maps, sec., table, July 1961, 11 refs.

The upper Cambrian Maynardville limestone was investigated through a strike length of 8 1/2 mi. in Jefferson and Sevier counties, Tennessee. A detailed composite columnar section shows 5 zones in the formation, from the base upward: 1) interbedded limestone and shale; 2) massive stromatolitic limestone; 3) oolitic and conglomeratic limestone, with thin stromatolitic beds; 4) massive and thick-bedded limestone, with a few dolomitic and stromatolitic layers; and 5) thin- to medium-bedded dolomite, with very little limestone. Extensive stromatolitic bioherms in Zone 2 contain subcircular forms, presumably the fossil outlines of algal colonies. Many intercolony fillings are composed of calcareous oolites and clastic sediments in a fine-grained calcitic matrix; others consist of dolomite and calcareous shale. Similar stromatolitic limestones were found in 8 other outcrop belts of the Maynardville in E. Tennessee. Five localities are listed where the algal colonies are well exposed in the outlying belts.--Auth.

3-3644. Yanov, E.N. DEVONIAN DEPOSITS OF SOUTHEAST GORNO-ALTAI (BASIN OF THE UPPER REACHES OF THE CHUI RIVER): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 530-532, May-June 1959, pub. 1960, 8 refs.

The Devonian of SE. Gorno-Altai is subdivided as follows: Barburgazy formation (D_3fr bb): fine-grained quartzofeldspathic sandstones with brachiopod fauna in lower section, max. thickness 6,500 m. Uzuntal formation (D_3fr us): varicolored siltstones and sand stones, max. thickness 900 m. Tashanty formation (D_2gv th): bedded dark feldspathic and quartzitic sandstones with brachiopod and crinoid fauna in calcareous facies, max. thickness 5,000 m. Yustyd series (D_2gv D_3fr): gray terrigenous, occasionally limey beds with large breaks. Sebystei formation(D_2gv sb): varicolored sandstones with tuff beds, max. thickness 1,200 m. Tashtyp formation(D_2e ts): dark silicified limestones with gypsum; brachiopod, coral, crinoid and bryozoan fauna; max. thickness 80 m. Sarzhematy formation(D_2e sr): upper part dacitic effusives and tuffs, lower part terrigenous clastics, max. thickness 2,000 m. Sailyugen series(D_2e gv): red, continental effusive-terrigenous beds with subordinate horizon of marine limestones. Lies with unconformity on Ordovician(?) and Silurian deposits.--F. Manheim.

3-3645. Vissarionova, A. Ya. CHARACTERISTICS OF THE LOWER CARBONIFEROUS TERRIGENOUS SECTION OF NORTHWESTERN BASHKIRIA: Geologiya Nefti - Petroleum Geology, v. 3, no. 6-B, p. 357-361, 3 figs., 1959, pub. 1961, 6 refs.

The paper describes the stratigraphy and lithology of the lower Carboniferous in northwestern Bashkiria, where rapid variations in composition and in thickness occur. Sandstones are present in the Tournasian as well as in the Stalinogorsk and Tula substages of the Visean, but their distribution is often uneven or lenticular. They either fill depressions eroded into earlier Tournaisian limestone beds or are the product of river courses or a changing sedimentary environment.--C. Voûte.

3-3646. Nekhoroshev, G.V. UPPER PALEOZOIC DEPOSITS IN THE MANRAK RANGE (EASTERN KAZAKHSTAN): Akad. Nauk SSSR, Doklady, Earth Sci Secs., in translation, v. 126, no. 1-6, p. 498-499, May-June 1959, pub. 1960, ref.

The upper Paleozoic deposits in the Manrak range have been divided into 3 formations: 1) a formation of andesite porphyrites and tuffs, with subordinate tuffites, sandstones, and shales; 2) quartz-bearing and dacitic porphyries with subordinate tuffs, sandstones, and shales; and 3) conglomerates, sandstones, and shales with layers of oil shale, coal, and rare limestone. On the basis of flora and fauna in the latter 2 formations the ages are considered to be middle and upper Carboniferous and late Carboniferous-Early Permian, respectively.--F. Manheim.

3-3647. Gofman, E.A. CONCERNING THE MIDDLE LIASSIC FORAMINIFERA OF THE NORTH CAUCASUS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 438-439, May-June 1959, pub. 1960, 4 refs.

Paleontological and stratigraphic studies in the N. Caucasus have shown that the middle Liassic deposits may be divided into a Pliensbachian and a Domerian stage. In addition to an abundant foraminiferal fauna, pelecypods, gastropods, and brachiopods provide supporting data for the regional correlation of these beds.--F. Manheim.

3-3648. Rostovtsev, K.O. BASAL BAJOCIAN DEPOSITS OF THE ZELENCHUK AND KUBAN' BASINS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 527-529, fig., May-June 1959, pub. 1960, 8 refs.

The Bajocian [Jurassic] deposits are widely distributed in the basins of the Bolshoi, Malji Zelenchuk, and Kuban rivers and extend in a wide band along the flank of the Skalistyi range. There is considerable controversy regarding the age of the basal horizon. The present studies indicate that the horizon of crinoidal limestones in the southern part of the region investigated is a basal unit of the Bajocian clay sequence and is included in the Sonninia sowerbyi zone. In a northeastward direction, toward the Cherkessk uplift the basal layers correspond in age to the upper Witchellia romani zone of the lower Bajocian.--F. Manheim.

3-3649. Moore, Clyde H., Jr. STRATIGRAPHY OF THE WALNUT FORMATION, SOUTH-CENTRAL TEXAS: Texas Jour. Sci., v. 13, no. 1, p. 17-40, 10 figs., chart, March 1961, 13 refs.

The Walnut formation [Lower Cretaceous] of S.-central Texas consists of 2 distinct members herein named the Bull Creek and Bee Cave. The Bull Creek, the lower member, is a limestone that onlaps the Glen Rose to the N. and W. The Bee Cave is a wedge of marl and clay that intertongues with the Comanche Peak to the SW. and W.

The 2 members differ radically in their petrographic and environmental characteristics. The Bull Creek is a clastic limestone which was deposited in relatively high energy conditions; the Bee Cave is a clay and lime mud deposited in a low energy environment. --Auth.

3-3650. Aliev, A.G. SOURCE AREAS OF DETRITAL MINERALS IN THE MESOZOIC-CENOZOIC DEPOSITS IN THE PETROLEUM REGIONS OF AZERBAIDZHAN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 484-486, May-June 1959, pub. 1960, 8 refs.

An attempt is made to distinguish clastic mineral provinces for Mesozoic-Cenozoic deposits in the Caspian-Kuba, Apsheron, Kabistan-Shemakha, Kura, Korovabad, and Lenkoran regions. Relationships of the heavy and light mineral fractions are discussed in the light of the structural developments of the areas concerned.--F. Manheim.

3-3651. Ganeshin, G.S., and I.A. Shilkina. FOSSIL WOOD OF CUPRESSINOXYLON CUPRESSOIDES KRÄUSEL IN DEPOSITS OF THE SUIFUN SERIES (SOUTH PRIMOR'E): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p.

418-420, 4 figs., May-June 1959, pub. 1960, 3 refs.

Description and discussion of the stratigraphic significance of fossil wood in ash beds of the Suifun series is given. It is concluded that the silicified wood is similar to forms described from Germany and is of Miocene age.--F. Manheim.

3-3652. Vasilev, Yu. M. THE STRUCTURE AND AGE OF THE SYRT DEPOSITS IN THE SOUTHERN TRANS-VOLGA REGION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 487-489, May-June 1959, pub. 1960, 16 refs.

The syrt deposits of the southern Trans-Volga region are composed to a large extent of loams, clays, and fossil soils resting on an erosion surface of sands. The buried soils are typically humus-bearing and contain lime concretions, gypsum, and Fe, as well as well-preserved mole burrows. The age of the deposits is regarded as Quaternary. The syrt sequence is similar to other blanket deposits and loess-like loams in the central part of the European U.S.S.R.--F. Manheim.

3-3653. Saks, V. N. SOME CONSIDERATIONS ON THE GEOLOGICAL HISTORY OF THE ARCTIC: Problems of the North - Problemy Severa, in translation, no. 1, p. 70-90, 5 figs., 1958, pub. 1960, 14 refs.

Much new information is available which is useful in interpreting problems in arctic geology: development of arctic structure, history of the ocean basin, paleoclimates, and polar migration. Three massifs bordering the Arctic have been stable since the Proterozoic: the Russian, Central Siberian, and Greenland-Canadian platforms. Lower Paleozoic folding formed a juncture of the Russian and Greenland-Canadian platforms which lasted until the Cenozoic. Sea-floor topographic studies and distribution of gravitational and magnetic anomalies provide evidence of Mesozoic folding involving Kotelnyy island, the Lomonosov ridge, and the Canadian archipelago. Cenozoic, especially late Tertiary, vertical uplift affected large areas of the Arctic. Development of the Arctic Ocean basin began in the late Mesozoic. Features in its history include land bridges between continents, a period when the Lomonosov ridge was above sea level, widespread changes in position of shoreline, and variations in the salinity of its water. Quaternary glaciation was not due to polar migration, for the ice ages were sumultaneous over the entire northern hemisphere. Three major glacial advances, with interglacial epochs marked by intrusion of warmer waters from the Atlantic, can confidently be distinguished. During the Tertiary, although the pole occupied the same place it now does, the Arctic Ocean was ice-free and the climate was comparatively warm and mild, caused in part by a general lack of high mountain systems dividing southern and northern Asia. Arctic climates during the Jurassic and Cretaceous fluctuated but were generally cooler than during the Tertiary; the pole was within the present polar basin. Triassic climates in the northern part of Siberia were moderately warm, and the pole was also located where it now is. A displacement of the pole from Cambrian through Permian times is indicated on the basis of lithologic and fossil characteristics but is difficult to explain on purely physical grounds. Climate in the Arctic during the greater part of the Paleozoic was markedly different from the present and even from Mesozoic climate; it was generally a time of warm, occasionally tropic, conditions and less pronounced zonality.--M. Russell.

3-3654. Antypko, B. E. THE SOUTHERN LIMIT OF THE PALEOGENE SEA ON THE SOUTHERN EDGE OF THE WESTERN SIBERIAN LOWLAND: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 461-464, 3 maps, May-June 1959, pub. 1960, 4 refs.

Study of the lithology and paleontology of marine Paleogene deposits along the southern border of the western Siberian lowland has shown that the southern boundary of the Paleogene sea shifted to the S. with time. The shoreline fluctuated markedly at the end of the Paleogene marine transgression. At maximum transgression the sea extended up to the projection of the folded basement, locally forming embayments into it.--F. Manheim.

3-3655. Herz, Norman, and others. AGE MEASUREMENTS FROM A PART OF THE BRAZILIAN SHIELD: Geol. Soc. America, Bull., v. 72, no. 7, p. 1111-1119, map, 2 tables, July 1961, 13 refs.

K-Ar determinations on micas from Precambrian granitic rocks of the Quadrilátero Ferrífero, Minas Gerais, Brazil, suggest 3 ages of intrusion: 2,400 m.y. determined from gneiss within the Bação complex; 1,350 m.y. from rocks in the northern part of the Bação complex and also in a region 7 km. N. of nearest known Minas series metasedimentary rocks (late Precambrian age); and 450-550 m.y. The last has been determined from 1) gneiss of the eastern part of the area, 2) granitized beds of the Minas series, and 3) granite between Minas beds and the 1,350 m.y. granite in the western part of the area. Other ages, ranging between 595 and 1,080 m.y., may represent the effects of a younger metamorphism on older granitic rocks that are found between the peripheral area of the 1,350 m.y. granites and Minas metasedimentary rocks.--Auth.

3-3656. Milashev, V. A., and N. I. Shulgina. NEW DATA ON THE AGE OF KIMBERLITES OF THE SIBERIAN PLATFORM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 518-519, fig., May-June 1959, pub. 1960, 9 refs.

A belemnite rostrum was found in the intersection of the Obnazhennyi kimberlite pipe with dolomites of the Sinian Turkut sequence. In spite of the poor state of preservation of the fossil it was possible to identify the belemnite as belonging to the genus Pachyteuthis, characteristic of the Upper Jurassic-Lower Cretaceous. Partly on the basis of this data it is concluded that the formation of a part of the Siberian kimberlites probably took place in Carboniferous-Lower Permian as well as in Cretaceous time.--F. Manheim.

3-3657. Starik, I. E., and others. THE ABSOLUTE AGE OF THE ROCKS OF THE EAST-ANTARCTIC PLATFORM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 429-431, table, May-June 1959, pub. 1960, 3 refs.

Two Proterozoic phases of migmatization within the lower E. Antarctic stage were found, one at more than 1,000 million years ago and a younger one at more than 700 million years ago. Blocks of gneiss in the Ainsworth Bay and Wilson uplands regions were found to have ages of 425-285 million years, nearly corresponding to the age of porphyroblastic granites in this region. Greenschists and micaceous phyllites forming the main part of the middle structural stage showed ages from 400 to 500 million years. The subalkaline biotite-hornblende granites had ages of 305-315 million years and gabbro-dolerites from the Becan series gave 170 million years (lower Triassic). Tertiary leucitic basalt from Mt. Gauss had an age of approximately 20 million years. The dating was carried out by the Ar method and should be considered preliminary.--F. Manheim.

3-3658. Fettke, Charles R. WELL-SAMPLE DESCRIPTIONS IN NORTHWESTERN PENNSYLVANIA AND ADJACENT STATES: Pennsylvania, Geol. Survey, Bull. M40, 691 p., 4 pls. (incl. 3 secs. in pocket), 1961, 26 refs.

This bulletin contains descriptions of rock cuttings obtained from wells drilled in search of oil and gas in northwestern Pennsylvania and adjacent states. These well-sample descriptions, produced by Charles R. Fettke during the many years that he was employed by the Pennsylvania Geological Survey (as a cooperating geologist), represent the foundation of his pioneering stratigraphic studies. Although many of the well-sample descriptions have been available as "separates," they have not, until the publication of this bulletin, been combined into one volume. The bulletin incorporates 52 well-sample descriptions, a location map, and 3 cross sections.--W. R. Wagner.

5. PALEONTOLOGY

See also: Areal and Regional Geology 3-3600; Stratigraphy 3-3643, 3-3647, 3-3651, 3-3656; Sedimentary Petrology 3-3840.

3-3659. Camp, Charles L., and H. J. Allison. BIBLIOGRAPHY OF FOSSIL VERTEBRATES, 1949-1953: Geol. Soc. America, Mem. 84, 532 p., 1961.

This volume is the fifth in a series listing and indexing publications in vertebrate paleontology and paleoanthropology for the years 1928-1953. Previous installments have been published by the Geological Society of America, the first 2 as Special Papers 27 and 42, the third and fourth as Memoirs 37 and 57. A sixth installment, 1954-1958, is in preparation. This series continues the North American bibliographies compiled by Oliver P. Hay up to and through 1928, and will supplement the bibliographies by Alfred S. Romer and his associates at Harvard for the extra-North American literature as far as the beginning of 1929.

The authors endeavor to list all publications on fossil vertebrates and fossil man, and they continue beyond the "fossil" period to the advent of cultivated plants and domesticated animals and/or metals and pottery. This is not the customary line of separation between the fossil and the Recent, but it is a fairly applicable criterion. If the "close of the Pleistocene" were to be taken as a final date much of interest would require omission. There would be little or nothing cited on fossil man and associated, but now extinct, vertebrates in North and South America. And there are difficulties in determining the "close of the Pleistocene" in nonglaciated parts of the world.

This bibliography is not selective. All citations known to the authors have been entered, even popular and anonymous references; and newspaper items are not wholly excluded. Articles missed in past issues of Hay and in our series are also caught up as soon as discovered. More complete indexing of past articles, originally labeled "not seen," has also been attempted. A few references in the systematic index are cited in advance, from 1954 to 1958, in order completely to explain the changes made in the synopsis of classification.--From pref.

Included in this volume are lists of serial abbreviations and serials, the author catalogue of references, subject index, systematic index, and a synopsis of classification.

3-3660. Alekseeva, R.E. A NEW GENUS OF THE FAMILY ATRYPIDAE GILL. (BRACHIOPODA): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 598-599, 3 figs., May-June 1959, pub. 1960, 2 refs.

A new genus of Atrypa is separated from the genus Atrypa Dalman, and named Vagrania. Genotype is Atrypa kolymensis from the Devonian of the Kolyma region, U. S. S. R. The new genus differs from other atrypid genera chiefly in its peculiar microstructure. --F. Manheim.

3-3661. Ochoterena F., H. VARIACION INTRAESPECIFICA EN PARATHYRIDINA MEXICANA N. SP., TEREBRATULIDO DEL OXFORDIANO DE MEXICO [Intraspecific Variations in Parathyridina mexicana n. sp., a Terebratulid of the Oxfordian of Mexico]: Mexico, Univ. Nac., Inst. Geologia, Paleontologia Mexicana, no. 9, 40 p., 13 figs., 2 pls., 1960, 27 refs.

The present work deals with a population of terebratulids of the Oxfordian [Upper Jurassic] of Mexico whose external features show great polymorphism. Statistical analysis of shell evolution and shape of the frontal suture shows that all the individuals belong to 1 species and that the morphological differences reflect intense intraspecific variation. This species is described as Parathyridina mexicana n. sp., with 3 related subspecies of intermediate type whose principal characteristics are 2, 3, or 4 plications in the frontal suture on which basis the subspecific varietal names biplicata, triplicata, and quadriplicata respectively have been designated. Probable lines of evolution within each group and their features of growth are discussed in the light of the statistical data.--Auth., translated by T. F. Rafter.

3-3662. McLearn, Frank H. AMMONOID FAUNAS OF THE UPPER TRIASSIC PARDONET FORMATION, PEACE RIVER FOOTHILLS, BRITISH COLUMBIA: Canada, Geol. Survey, Mem. 311, 118 p., 3 figs., 21 pls., 3 tables, 1960, 61 refs.

The purpose of this memoir is to assemble, coordinate and revise information published in many short papers in the Transactions of the Royal Society of Canada, the Canadian Field-Naturalist, and the Preliminary Series of the Geological Survey of Canada. Ammonoid faunal zones, correlation, and systematic paleontology are treated. The stratigraphic succession, based mainly on an integration of ammonoid sequences on Pardonet and Brown hills and on sequences at many other localities, comprises, in ascending order, the Stikinoceras zone, Tropites bed, Styrites ireneanus zone, Pterotoceras-Cyrtopleurites magnificus beds. Drepanites beds, Cyrtopleurites beds, Parathisbites oineus beds, Himavatites zone, Monotis subcircularis zone, and the Rhacophyllites beds. The Stikinoceras and Styrites ireneanus zones contain a number of species in common. Together with the Tropites bed they are incorporated into a Gonionotites-Malayites major zone. The Monotis subcircularis zone contains few ammonoids and is named for a pelecypod. Rhacophyllites is not confined to the Rhacophyllites beds, but ammonoids are poorly represented in Triassic beds above the M. subcircularis zone.

The Gonionotites-Malayites major zone is correlated with the upper Karnian stage of the Hallstatt Alpine succession, although the diagnostic genus Tropites is only recorded at one locality in the Peace River foothills and only by a single specimen in place. Malayites suggests correlation with the Karnisch-norischen Mischfaunal zone of the Hallstatt region. The Peace River zone, however, lacks any diagnostic Norian elements, and the Mischfaunal zone is not recognized by all authorities. The Pterotoceras-Cyrtopleurites magnificus fauna is tentatively dated Norian, and the Drepanites and Cyrtopleurites beds are definitely Norian. The Himavatites zone is correlated with the lower Norian Cyrtopleurites bicrenatus zone of the Hallstatt zone, and the M. subcircularis zone and Rhacophyllites beds are dated upper Norian.

Forty-nine genera are recognized; 53 species are identified, 19 are compared with foreign species, 27 are not specifically identified, but merely generically. No new genera or species are proposed.--Auth.

3-3663. Tikhomirov, B.A. NATURAL CONDITIONS AND VEGETATION IN THE MAMMOTH EPOCH IN NORTHERN SIBERIA: Problems of the North - Problemy Severa, in translation, no. 1, p. 166-188, 8 figs., 1958, pub. 1960, 32 refs.

Early speculation that the diet of the extinct Siberian mammoth Elephas primigenius Blum consisted of conifers was disproved when the stomach content of the Berezovka mammoth was found to consist of grasses essentially. A spore and pollen analysis revealed 53 different plants. The Taymyr mammoth was buried in place of death so that an examination of the environment of deposition revealed much about the mammoth's habitat at time of death. Extinction of the Siberian mammoth is dated as postglacial.--M. Russell.

3-3664. Dalquest, Walter W. A RECORD OF THE GIANT BISON (BISON LATIFRONS) FROM COOKE COUNTY, TEXAS: Texas Jour. Sci., v. 13, no. 1, p. 41-44, March 1961, 5 refs.

Brief descriptions are given of fossils from Pleistocene gravel pit deposits, South Fish Creek near Munster, discovered in 1959. Fossils included small fishes, amphibians, reptiles, and rodents, and a horn core from Bison latifrons, previously unrecorded from northern Texas. The Bison latifrons horn-core fragment measures 470 mm. in length and is approximately 140 mm. in diameter at the broad end. The longitudinal flutings are deep and prominent. A few small hollows at the broad (proximal) end suggest that this point may have been the termination of the basal hollow. Apparently the horn-core was nearly circular in cross-section. It is only slightly curved. The basal diameter of the specimen, about 140 mm., must have been located approximately 15 to 18 ins. from the base of the horn-core.--A. C. Sangree.

3-3665. Galloway, J. J. A MANUAL OF FORAMINIFERA: 483 p., 42 pls., Bloomington, Indiana, Principia Press, 1933: reprinted as McLean Paleont. Lab., Classics in Paleontology, no. 1, 1961. Available from: McLean Paleontological Laboratory, P.O. Box 916, Alexandria, Virginia.

The need for more accurate nomenclature, discrimination, and definition of families, genera, and species of Foraminifera, their geographic and geologic ranges, their habitats and relationships to each other, by the several hundred paleontologists working on problems in petroleum geology, is the reason for the present revision of the classification and phylogeny of the Foraminifera.

In the present work the author has attempted to include a restudy of every generic name ever used for Foraminifera up to June 1932, and to define them as valid genera, or place them in synonomy or as unrecognizable generic names, or as not belonging to Foraminifera. The author has also attempted to give a reproduction of the type figure of every valid genus. In a few cases there were no figures, or the figures were too indefinite to be reproduced by pen and ink. In such cases, supplementary figures are given of authentic specimens showing the generic characters, or idealized figures are used. The attempt has been to be accurate and complete.--From auth. pref.

Under each genus is given the author, date, the genotype and the reason it is the type, by whom, when, and where the genus was first defined and illustrated, the age and original locality of the genotype, important references, and all determined synonyms. Then comes a complete description of each genus, taking up each in the same manner: how it occurs, the shape of the test, the character of the chambers and method of addition, the character of the wall and ornamentation, the character of the aperture, and the range in size of adult specimens. This is followed by the habitat of living species, the range of described species as determined by examination of published descriptions, figures and ranges, and personal experience. The phylogenetic treatment makes it easy to tell whether a new genus is really different, where it belongs, and makes the genera easily understood. Keys are given for each family, subfamily, and genus. The magnification of the figures is not given; sizes of specimens are included in the generic descriptions.

Under each family is given the reference to the first valid name used for that family, and this is followed by a complete definition of the family, with the habitat and geologic range. This is followed by a phylogenetic tree, showing the ancestor of the family, the division into subfamilies and the relationships of all the genera. Then comes a discussion of the classification and evolution of the family, taking into account the structure, ontogeny, geologic range, habitat, and other factors bearing on the phylogeny of the family. Keys to the subfamilies are followed by complete descriptions of the subfamilies, and these by keys to the genera and discussions of the genera.--From introd.

3-3666. Krylov, I. N. STROMATOLITES FROM THE RIPHEAN OF THE URALS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 512-514, fig., May-June 1959, pub. 1960, 15 refs.

Stromatolites from the Riphean sections of the Urals were found to be valuable stratigraphic markers. Varieties of Collenia, Conophyton, and Gymnosolen were identified and compared with forms from the Belt series, the Congo, and Siberia. The recrystallization of the limestones and dolomites forming the stromatolites made it impossible to detect cellular microstructures and therefore only the gross form was investigated.--F. Manheim.

3-3667. Korde, K. B. THE MORPHOLOGY AND SYSTEMATIC POSITION OF REPRESENTATIVES OF THE GENUS *EPIPHYTON*: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 603-606, fig., May-June 1959, *pub.* 1960, 8 refs.

Samples of the controversial genus *Epiphyton* from the Cambrian of Siberia show some similarities with present-day blue-green and red algae, particularly the Corallinaceae. However, *Epiphyton* shows a thallus with multilayered cellular structure and sporangia, features not observed in blue-green algae. It is also distinguished from coralline algae by jointing and absence of characeous layers. Accordingly, the genus *Epiphyton* is placed in an independent family, Epiphytonaceae, having a geologic range from Cambrian to Devonian.--F. Manheim.

3-3668. Ushko, K. A., and L. S. Isaeva-Petrova. NEW DATA ON THE PLIOCENE FLORA OF WESTERN TURKMENIA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 600-602, fig., May-June 1959, *pub.* 1960, 2 refs.

Leaves, herb stems, and remains of small fruits in the Cheleken red beds confirm the fresh-water continental origin of these beds. The lower Akchagyl deposits of Boya-Dag show marine indications with some plant remains, the latter being explained by transport from a nearby land mass. The Apsheron flora in the Pereval-Aidin ridge and in the southern limb of the Monzhukla uplift indicate fresh-water, lacustrine-deltaic conditions. The occurrence of massive floral accumulations is linked to specific phases of the regression of Pliocene marine basins in western Turkmenia.--F. Manheim.

3-3669. Trofimov, Yu. M. SEED PLANTS FROM THE QUATERNARY DEPOSITS ALONG THE LOWER REACHES OF THE ALDAN AND LENA RIVERS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 481-483, fig., table, May-June 1959, *pub.* 1960.

Combined carpological and pollen studies have been carried out on the Quaternary flora of Yakutia. Most of the plants are characteristic of swampy lacustrine landscapes and severe climates, with forest-tundra types dominant. The authors concur with Dorofeev in placing the investigated deposits in the Riss or Riss--Würm of Europe. An improvement in climate in recent time is indicated.--F. Manheim.

3-3670. Lamakin. V. V. POLLEN FROM DARK-CONIFER FORESTS IN THE QUATERNARY DEPOSITS OF OLKHON ISLAND IN LAKE BAIKAL: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 607-609, table, May-June 1959, *pub.* 1960, 8 refs.

Pollen analyses of bottom sediments of 2 Olkhon lakes point to a considerable distribution of forests on Olkon in the past. A damper climate is also indicated, and a decrease in quantity of spruce pollen upwards is probably due to the gradually increasing aridity at the time the sediments were deposited. It is possible that siberian pine was preserved on Olkhon as a relic for some time after the glacial epoch.--F. Manheim.

3-3671. Butler, E. Ann. PALEONTOLOGY OF THE L. L. & E., ET AL. WELL, UNIT 1-L, NO. 1: Louisiana, Geol. Survey, Folio Ser. no. 1, 4 sheets, illus., log, chart, Feb. 1960, ref.

A paleontological study of the deepest well drilled in Louisiana, located on the Lake Washington dome in Plaquemines Parish. It was drilled to total depth of 22,570 ft. and bottomed in the Miocene, being completed in May 1956. The area is one of unusually thick sedimentary accumulation and prolific oil and gas production.

Cuttings received by the Louisiana Geological Survey started at a depth of 8,487 ft. Zones observed in these and other sets of cuttings were: 10,242 ft., *Bigenerina directa*; 14,674 ft., *Textularia* aff. *T. stapperi*; 15,744 ft., *Bigenerina humblei*; 20,856 ft., *Robulus* (43). The electrical log charts on the first 3 sheets show illustrations of the species at the depths where first encountered. As no cores were taken, exact stratigraphic ranges could not be determined. The fourth sheet is a chart showing the range of the species in this particular set of cuttings.--A. C. Sangree.

3-3672. Vyalov, O. S., and L. S. Pishvanova. NEW DATA ON THE LOWER TORTONIAN FAUNA OF PODOLIA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 470-472, 3 figs., May-June 1959, *pub.* 1960, 11 refs.

A varied fauna consisting chiefly of Foraminifera, Bryozoa, pelecypods, oysters, calcareous algae, serpulids, ostracods, and echinoids is described from the lower Tortonian [Miocene] of the western Ukraine. Curious rodlike sandy concretions were found protruding from the weathered surfaces of friable sandstones. These growths are 1-5 cm. in diameter and 5-10 cm. long, occasionally reaching 70 cm. Similar forms have been called rhizolites or ophiomorphs in the literature, although their origin is not clear. The present authors regard the forms as crustacean burrow fillings. The general environment was a littoral zone in a basin of moving water.--F. Manheim.

6. GEOPHYSICS

See also: Geologic Maps 3-3573 through 3-3579, 3-3581; Geochemistry 3-3764; Mineral Deposits 3-3877; Fuels 3-3903; Engineering Geology 3-3909, 3-3918.

3-3673. Baile, Richard A. CURRENT AND FUTURE PARAMETERS IN GEOPHYSICS: Geophysics, v. 26, no. 3, p. 355-358, June 1961.

Oil exploration people are responsible for developing a program adequately to satisfy an anticipated world-wide demand of 50 million barrels of oil per day by 1975. It is apparent that we must continue the search with increased effort if we are to maintain our present competitive position as prime suppliers of energy. One of the main reasons why our position is less secure than it was a decade ago is that the return on investment in exploring for oil in the United States is poor. The solution lies in maintaining petroleum competitive with other producing areas. Exploration is the key to meeting this challenge. Four prime factors are considered in relation to satisfying this objective. They are exploration planning, exploration personnel, exploration research, and finally exploration stability — the key to effective growth.--L. M. Dane.

3-3674. Cook, A. H., and T. F. Gaskell, eds. THE EARTH TODAY. A Collection of Papers Dedicated to Sir Harold Jeffreys by Some of His Students and Colleagues on the Occasion of His 70th Birthday: 404 p., illus., maps, diags., graph, tables, London, Royal Astronomical Society; New York, Interscience Publishers, 1961, refs.

The Earth Today is a special issue of the Geophysical Journal (Vol. 4), dedicated to Sir Harold Jeffreys. It contains an appreciation of Jeffreys' work by R. Stoneley and 27 papers by an international group of specialists, papers representing some of the most advanced work in geophysics at the present time in fields in which Jeffreys has been interested. Five papers deal with the earth's gravitational field and geodesy, 12 deal with seismology and free oscillations of the earth, 3 with thermal state, 3 with the earth's composition, 2 with the atmosphere and oceans, and 2 with instruments. All papers on solid earth geophysics are separately abstracted in the geophysics section of this issue of GeoScience Abstracts.--A. C. Sangree.

3-3675. Bonchkovsky, V. F., and A. N. Skuryat. THE LEVEL VARIOMETER LV: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 47-54, 10 figs., 3 refs.

Contains a description of construction, dynamic characteristics, determination of excesses, and analysis of work with this instrument which records variations in elevation of the earth's surface.--A. C. Sangree.

3-3676. Jackson, J. E. THE CAMBRIDGE PENDULUM APPARATUS (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 375-388, 7 figs., New York, Interscience Publishers, 1961) 25 refs.

The 3-pendulum method, developed and used by Lenox-Conyngham, was superseded in 1930, on the arrival of a new vacuum box for swinging 2 pendulums. With 3 invar pendulums taken over from the earlier apparatus and 3 new ones acquired in 1931, this box is the centerpiece of the apparatus which has been in use up to the present day for geophysical investigations and for establishing gravity reference stations in many parts of the world. This article describes briefly the apparatus and the various modifications of procedure and changes of auxiliary gear that have taken place in the past 30 years. A list of the work done with the apparatus is given.--Auth.

3-3677. Kaula, William M. A GEOID AND WORLD GEODETIC SYSTEM BASED ON A COMBINATION OF GRAVIMETRIC, ASTROGEODETIC, AND SATELLITE DATA: Jour. Geophys. Research, v. 66, no. 6, p. 1799-1811, 3 figs., 3 tables, June 1961, 17 refs.

A world-wide estimate of the gravity field was combined with an estimate of the geoid and with variations in satellite orbits in least-squares adjustment which was generalized by taking correlation into account. The gravity-field estimate was based on all available gravimetry and was extended by using correlation with elevation in a Markov analysis. The estimated geoid was based on astrogeodetic data covering 19% of the earth. Secular and long-period variations of the 1957β and 1958β satellite orbits were used. The value obtained for the quadratic sum indicated that the estimates of variance and covariance should be increased about 44%.

Results obtained include equatorial radius: 6,378,163 ± 21 m.; flattening: 1/298.24 ± 0.01; equatorial gravity: 978,043.6 ± 1.2 milligals (Potsdam system); datum shifts (with three-dimensional standard deviation) for the Americas system (± 35 m.); Europe-Africa-Siberia-India system (± 38 m.); Japan-Korea-Manchuria system (± 68 m.); coefficients in the spherical harmonic expression of the gravity field up to the eighth degree; world-wide geoid heights having standard deviation varying from ± 10 to ± 22 m.--Auth.

3-3678. Marussi, Antonio. INTRINSIC COORDINATES IN PRACTICAL GEODESY (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 83-89, New York, Interscience Publishers, 1961) 7 refs.

The basic ideas that support intrinsic geodesy, i.e. the discipline which aims at the local description of the gravity field of the earth by using only coordinates and quantities that have a physical reality and that are therefore accessible to actual observation, are recalled.

It is shown how the integrability conditions necessary for the existence of the coordinate surfaces, and the fundamental operators, e.g. the Christoffel symbols of the second kind connecting the principal trihedra of the intrinsic coordinate system, may be expressed in terms of the curvature parameters of the field, and of gravity.

An application of the theory is made to a classical geodetic problem, i.e. the generalized expansion of Legendre for the displacement of the potential (the dynamic height) along an optical path.--Auth.

3-3679. Munk, Walter H., and El Sayed Mohamed Hassan. ATMOSPHERIC EXCITATION OF THE EARTH'S WOBBLE (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 339-358, 8 figs., 3 tables, New York, Interscience Publishers, 1961) 14 refs.

Hassan has computed mean monthly values of the atmosphere's moments and products of inertia for the period 1873 to 1950, using all available station-level pressures. On the basis of these time series the excitation of the seasonal and 14-month (Chandler) wobble is discussed.

With respect to the seasonal wobble, our calculations confirm the conclusion by Jeffreys and others that it is due largely to atmospheric excitation. By working directly with station-level pressures we have avoided the procedure followed previously of removing the sea-level correction from sea-level pressure charts (thus "uncorrecting" for a large and undesirable correction). Our amplitudes are 25% smaller than those given by Jeffreys.

With respect to the Chandler wobble, it has been suggested by Jeffreys, Rudnick, and by Munk & MacDonald that this represents a resonance amplification of the irregular (non-seasonal) variation in atmospheric inertia. The computed spectral density of the atmospheric variation at the Chandler frequency falls short by 1 or 2 orders of magnitude to meet the requirement of this hypothesis. Excitation by irregular motion in the core is briefly considered. Here the electromagnetic coupling (limited by conductivity in the lower mantle) appears to be far too weak to account for the observed wobble. The excitation of the Chandler wobble must be considered an unsolved problem.--Auth.

3-3680. Graf, Anton, and Reinhard Schulze. IMPROVEMENTS OF THE SEA GRAVIMETER Gss2: Jour. Geophys. Research, v. 66, no. 6, p. 1813-1821, 13 figs., table, June 1961, 6 refs.

Several improvements made on the Askania 'Sea Gravimeter Gss2 after Graf' have considerably widened the scope of application of this instrument. Some of these alterations are described. The phenomena resulting from the heavier damping used are treated in detail. In the laboratory, the sea gravimeter was subjected to accelerations up to ±100,000 mgal. It was found that these accelerations cause discrepancies of only about 2 mgal between the static value and the mean dynamic value. Completely irregular accelerations with peaks up to 200,000 mgal yielded dynamic mean values which did not appreciably deviate from the static value. With the new gyrostabilized platform it is now possible to obtain results of a very high order of accuracy and precision even in rather rough seas. All the various disturbing effects predicted by theory can now be either eliminated by a suitable measurement procedure or else accounted for.--Auth.

3-3681. King-Hele, D. G. THE EARTH'S GRAVITATIONAL POTENTIAL, DEDUCED FROM THE ORBITS OF ARTIFICIAL SATELLITES (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 3-16, diag., New York, Interscience Publishers, 1961) 33 refs.

The numerical values of several of the higher harmonics in the earth's gravitational potential have been obtained from the perturbations to the orbits of satellites. This paper describes the relevant methods, cursorily reviews previous results, and gives details of a fresh determination of the second, fourth and sixth harmonics from the orbits of Sputnik 2, Vanguard I, and Explorer 7.--Auth.

3-3682. Tsuboi, Chuji. NUMERICAL TABLES USEFUL FOR STUDYING THE GRAVITATIONAL FIELD AT HIGHER ELEVATIONS OF THE EARTH (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 73-82, 3 figs., 4 tables, New York, Interscience Publishers, 1961) 2 refs.

Expressions for the gravitational potential and force at a point (not necessarily on the earth's axis) at any higher elevation of the earth have been obtained in a simple summation series form in terms of zonal averages of surface gravity anomalies taken around the axis passing through the point. Numerical values to be multiplied to zonal averages of gravity anomalies in order to obtain the potential and force are given in tables. If the elevation is zero, our values for the potential naturally agree with those of Lambert's Q function.--Auth.

3-3683. Innes, Morris, J. S. THE USE OF GRAVITY METHODS TO STUDY THE UNDERGROUND STRUCTURE AND IMPACT ENERGY OF METEORITE CRATERS: Jour. Geophys. Research, v. 66, no. 7, p. 2225-2239, 7 figs., 5 tables, July 1961, 19 refs.

Gravity data have been used to calculate the mass deficiency and hence the amount of shattered rock under the Deep Bay, Brent, and Holleford craters [in the Canadian Shield]. The results show good agreement with the crater model computed by Rottenberg as combined with the depth/diameter ratios of Baldwin for meteorite impact craters. The zone of complete rupture is shown to extend to a depth of approximately one-third of the crater's diameter, and impact energy values, derived from energy of crushing are 6.5×10^{23} ergs, 2.1×10^{24} ergs, and 8.7×10^{25} ergs for Holleford, Brent, and Deep Bay, respectively.--Auth.

3-3684. Cook, Kenneth L., and Joseph W. Berg, Jr. REGIONAL GRAVITY SURVEY ALONG THE CENTRAL AND SOUTHERN WASATCH FRONT, UTAH: U. S. Geol. Survey, Prof. Paper 316-E, p. 75-89, 2 maps incl. col. geol. (in pocket) scale 1:250,000, 1961, 47 refs.

A regional gravity survey was made from June to Aug. 1954 in Salt Lake and Utah counties, Utah. Gravity measurements were made at 1,100 stations in an area of about 5,000 sq. mi. and the results were compiled as a Bouguer gravity anomaly map with a contour interval of 2 milligals.

Past tectonic activity in the region has been great, and the regional gravity patterns reflect the present contrasts in the crust that are the product of several orogenies. A gravity high occurs over the ancient northern Utah highland in the Antelope Island area. The gravity data give no evidence that the Uinta arch extends W. of the Wasatch front. Steep gravity gradients corresponding with Basin and Range faults occur along parts of the Wasatch fault zone on the W. margin of the Wasatch Range; along a continuous fault zone 60 mi. in length on the W. margin of the Oquirrh Mountains, Boulter Ridge, and East Tintic Mountains; and along the newly discovered Utah Lake fault zone E. of West Mountain and the Lake Mountains. A gravity high corresponds with the great fault block comprising the Oquirrh Mountains, Boulter Ridge, and the northern part of the East Tintic Mountains.

The gravity data indicate that in the valley areas between this fault block and the Wasatch fault block, an intermount trough (designated by us as the Wasatch structural trough) more than 100 mi. in length comprises a great belt of grabens and smaller fault blocks whose dislocations are varied and more complex than previously realized. Several large block fragments lying just W. of the Wasatch block have apparently dropped deeper than some other fragments, as if slipping into a great crevasse. From N. to S., the major grabens are the Farmington, Jordan Valley, Utah Valley, and Juab Valley grabens. The major fault-block spurs are the eastern part of the Traverse Mountains and the spur in the Santaquin area.--Auth.

3-3685. Lazarev, G. E., and S. A. Ushakov. A TEST OF THE DETERMINATION OF THE THICKNESS OF ICE IN THE ANTARCTIC FROM GRAVIMETRIC MEASUREMENTS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 543-545, fig., May-June 1959, pub. 1960, 8 refs.

Gravity measurements are recommended to accompany seismic determinations of the thickness of the Antarctic ice cover. In addition to more accurate thickness measurements, data are gained on the nature of the earth's crust under the ice. For the interpretation of the gravity data obtained in the present study both Bouguer corrections and the method of Numerov were used.--F. Manheim.

3-3686. Weinberg, A.K. A GRAPHIC METHOD FOR DETERMINING THE DEPTH OF MAGNETIZED BODIES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 35-39, 9 figs., 8 refs.

The proposed method can be applied to mass standard processing of ΔT aeromagnetic survey materials. High quality first-hand materials (magnetograms) that are on a large scale (high rate of recording) must be used if the method is to be successfully applied.--Auth. concl.

3-3687. Jacobsen, Peter, Jr. AN EVALUATION OF BASEMENT DEPTH DETERMINATIONS FROM AIRBORNE MAGNETOMETER DATA: Geophysics, v. 26, no. 3, p. 309-319, 5 figs., June 1961, 4 refs.

Four years ago Creole Petroleum Corp. submitted identical airborne magnetometer data for a portion of the eastern Venezuela basin to 2 different geophysical contractors for independent, detailed analysis. These contractors offer the customary generalized basement depth maps, but they specialize in delineating areas of relatively local relief on the basement surface. Both kinds of interpretation were requested by Creole. The main purpose of the study was to evaluate the reliability of interpretations of local basement relief from magnetic data. Accordingly, the region for study was deliberately chosen to include, in part, areas for which Creole had considerable knowledge of basement depths and local basement configuration from other sources. Local basement relief shown by the 2 magnetic interpretations is in poor agreement with basement depth information from seismograph and well data. Moreover, the 2 magnetic pictures bear little resemblance one to the other. With respect to regional basement depth contours, one of the magnetic interpretations compares satisfactorily with the picture based on seismograph and well control. A tentative conclusion is that local basement relief cannot be reliably interpreted from magnetometer data alone.--Auth.

Discussions of the paper are also included. Contributors are R. J. Bean, Walter R. Fillippone, Norman R. Paterson, and Isidore Zietz.

3-3688. Linkova, T.I. LABORATORY STUDIES OF THE NATURAL REMANENT MAGNETIZATION OF DIRECT AND REVERSE MAGNETIZED DEVONIAN ROCKS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 55-58, 6 figs., table, 8 refs.

Study of the behavior of the vector I_n showed that the specimens of Devonian sedimentary rocks studied were magnetostable and, consequently, suitable for paleomagnetic studies. Demagnetization in constant and variable fields did not reveal differences in the behavior of normal and reverse magnetized rocks.

Thermomagnetic analysis revealed that N and R magnetized rocks contain the same minerals. Petrographic and chemical analysis also failed to reveal differences in the composition of N and R magnetized specimens. The results suggest that there is conversion of the earth's magnetic field.--Auth. concl.

3-3689. Irving, E., and others. TREATMENT OF PARTIALLY STABLE SEDIMENTARY ROCKS SHOWING PLANAR DISTRIBUTION OF DIRECTIONS OF MAGNETIZATION: Jour. Geophys. Research, v. 66, no. 6, p. 1927-1933, 5 figs., table, June 1961, 17 refs.

Viscous magnetization is often imposed on rocks by the earth's magnetic field in geologically recent times so that the directions of magnetization measured in specimens from the same site are often strung out between the stable direction of magnetization and the present earth's field. Such viscous components are an important source of error in paleomagnetic work. This paper shows how, in some upper Carboniferous sediments, these viscous components may be removed by partial thermal demagnetization so that the initial planar distribution condenses around the direction of the stable magnetization. The demagnetization was carried out by heating in an inert atmosphere in a nonmagnetic oven followed by cooling in zero field. Application of Graham's fold test shows that this stable magnetization is of very great antiquity, certainly pre-Triassic and probably pre-Permian in age.--Auth.

3-3690. Irving, E., and M. R. Banks. PALEOMAGNETIC RESULTS FROM THE UPPER TRIASSIC LAVAS OF MASSACHUSETTS: Jour. Geophys. Research, v. 66, no. 6, p. 1935-1939, 2 figs., table, June 1961, 10 refs.

The directions of magnetization at 5 sites in 2 lava members of the Newark group of Massachusetts have been measured. The directions have fairly consistent northerly declinations, but the inclinations are highly variable. This variation is shown to be due to the presence of a soft magnetic component of variable magnitude approximately parallel to the present earth's field, the effect of which is removed in alternating magnetic fields of 150 oersteds. The magnetization remaining after the removal of this "soft" component has a mean direction (010°, +16°) which is consistent with the paleomagnetic pole position at 55°N. 88°E. This agrees well with other Triassic paleomagnetic pole determinations from the United States.--Auth.

3-3691. Opdyke, N. D. THE PALEOMAGNETISM OF THE NEW JERSEY TRIASSIC: A FIELD STUDY OF THE INCLINATION ERROR IN RED SEDIMENTS: Jour. Geophys. Research, v. 66, no. 6, p. 1941-1949, 8 figs., 4 tables, June 1961, 27 refs.

It has previously been reported that on redeposition in the laboratory the magnetization of both red sediments and varves has a systematic error in inclination which could be a serious source of error in paleomagnetic work. To test whether such an error occurs in nature, the directions of magnetization measured in specimens from intrusions, extrusions, and red sediments of the Newark system have been compared. There is no significant difference between the stable directions in each type of rock, showing that no important error in inclination occurs in the sediments.--Auth.

3-3692. Evison, F. F. ROCK MAGNETISM IN WESTERN EUROPE AS AN INDICATION OF CONTINENTAL GROWTH (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 320-335, 4 figs., 2 tables, New York, Interscience Publishers, 1961) 35 refs.

The paleomagnetic interpretation of rock magnetism had led to an increasingly elaborate set of geodynamic postulates, which now include polar wandering, continental drift, and the rotation of continents and parts of continents. An alternative approach is suggested by the hypothesis of widespread continual plastic flow of basement rocks. Remanence data for western Europe are analysed from this viewpoint, assuming that the position of the poles has always been virtually the same as at present. The inferred pattern of flow is away from the high standing interior and towards the northeastern Atlantic basin. The amount of flow increases with the age of the rock; an accelerated rate of flow is indicated during the Hercynian revolution and a relatively slow rate in more recent times. These results are in accord with the concept of continental growth by plastic flow under gravity.--Auth.

3-3693. Bouha, V. SOME RESULTS OF PALEOMAGNETIC INVESTIGATIONS OF PRIMARY IGNEOUS ROCKS IN CZECHOSLOVAKIA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 31-34, 4 figs., table, 5 refs.

Geomagnetic pole positions were determined from Upper Cambrian rock samples obtained in 11 different regions. The results are only provisional, although they supplement the hitherto extremely meager Cambrian data. The present study once more emphasizes the possibilities of paleomagnetic research.

The results obtained in paleomagnetic investigations of different formations from the most ancient periods exhibit a broad spread of geomagnetic pole positions for those epochs. It may hereafter be possible to account for the broad distribution of early Precambrian positions that were reported by Irving. --Auth. concl.

3-3694. Kruglyakova, G. I. RESULTS OF PALAEOMAGNETIC RESEARCH ON THE UKRAINIAN CRYSTALLINE MASSIF AND ADJACENT REGIONS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 150-153, 3 figs., table 7 refs.

Field selection of the rock material must be from individual massifs, not from combined formations which usually include a series of massifs, sometimes of different composition, that closer study may show to be of different ages.

Paleomagnetic investigation of magmatic rocks should not be confined to determining the direction of the remanent-magnetization vector. The ratio of remanent to induced magnetization must also be investigated. The age of the massif should be determined from both parameters: the direction of I_r and the value of $Q = I_r/I_i$.

The work done on the Ukrainian crystalline massif showed that it is well worth determining the relative ages of rocks from the amount and direction of their magnetization. The amount and direction of magnetization in the massifs studied provide corroboration of the main stages of magmatic activity which occurred during the formation of the Ukrainian crystalline massif.

The paleomagnetic results obtained fit in well with the geological ideas and with the published results of absolute age determinations.--Auth. concl.

3-3695. Vinogradov, P. A. THE ANOMALY IN THE EARTH'S ELECTRIC FIELD IN THE REGION OF THE USHKAN'I ISLANDS (LAKE BAIKAL): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 549-551, 3 figs., 2 tables, May-June 1959, pub. 1960, 6 refs.

Potential differences in the terrestrial electric field were measured in lake Baikal using 2 mutually perpendicular measuring dipoles. Lead electrodes were found suitable as the measuring sondes. The amplitude of the irregular oscillations averaged 250-300 millivolts/kilometer on a day of strong disturbances. Maximum amplitude was 1,679 mv./km. Interpretation of the resistance charts also showed a rise in the apparent resistance at the shores of lake Baikal and adjoining regions compared with the resistance of the deeper layers.--F. Manheim.

3-3696. Ivanov, M. A., and B. S. Enenshtein. A NONINERTIAL METHOD FOR MEASURING THE AMPLITUDES AND PHASES OF ELECTRIC OSCILLATIONS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 154-157, 10 figs.

This method for measuring the amplitudes and phases of electric oscillations of low and infralow frequencies has considerable advantages over the normal methods, largely because of the lack of inertia of the apparatus and because the measurement results can be read rapidly. The apparatus is also suitable for measuring signals complicated by nonperiodic noise, and the mean value of these signals can be rapidly and objectively estimated. It does not include any measuring instruments that are liable to be mechanically affected. This makes it especially suitable for work under field conditions. A circuit of this type will be found most useful when a large number of measurements have to be made. An important factor for work at low frequencies is that the time spent in measuring and in processing the results is greatly reduced.--Auth. concl.

3-3697. Cook, Kenneth L., and Russell L. Gray. THEORETICAL HORIZONTAL RESISTIVITY PROFILES OVER HEMISPHERICAL SINKS: Geophysics, v. 26, no. 3, p. 342-354, 9 figs., 2 tables, June 1961, 12 refs.

An album of 40 sets (about 200 different curves) of theoretical horizontal resistivity profiles over and near outcropping hemispherical sinks shows the effects of sink diameter, reflection factor k, and distance of the traverse from the center of the sink upon the magnitude and shape of the apparent resistivity curves. Curves for sink diameters of 16a, 8a, 6a, 4a, 2a, a, and 0.5a, and reflection factors k of ±0.8, ±0.6, ±0.4, and ±0.2 are included. The values of apparent resistivity for both the Lee and Wenner configurations were computed using a digital computer. In general, the larger the sink, the larger the magnitude of the apparent resistivity anomaly up to a sink diameter of about 8a, for which the apparent resistivity over the central part of the sink is essentially equal to the resistivity of the sink, irrespective of the reflection factor. For sink diameters equal to the electrode separation a, large apparent resistivity anomalies result from "pseudo-focusing" effects. The major peaks of the apparent resistivity curves, which lie outside the edges of the sink for negative reflection factors and inside for positive reflection factors, can be used to detect the edges of the sinks. The album of curves provides a general utility for the qualitative interpretation of apparent resistivity anomalies over features other than hemispherical sinks, such as faults (for large sinks), dikes, grabens, and similar features.--Auth.

3-3698. Dmitriev, V.I. THE SCREENING OF AN ANOMALOUS FIELD BY SEDIMENT: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 27-30, 3 figs., 2 refs.

In electrical prospecting it is very important to take into account the effect produced by a layer of sediment. The present paper gives a solution for the case in which a conducting layer covers the surface of the homogeneous half-space enclosing the vein.

The solution in the presence of sediment is obtained by the same method used for an enclosing homogeneous half-space. The solution is obtained in the form of an absolutely and uniformly converging series. In order to attain the required degree of accuracy, more terms of the series must be taken in the present case than for a homogeneous half-space. It is sufficient in practice to take 2 terms of the series for a thin sedimentary deposit, and 3 terms for greater thicknesses.--Auth., p. 27.

3-3699. Lishman, John R. SALT BED IDENTIFICATION FROM UNFOCUSED RESISTIVITY LOGS: Geophysics, v. 26, no. 3, p. 320-341, 14 figs., June 1961, 6 refs.

Salt beds have almost infinite electrical resistivity. They differ from other infinitely resistive beds in that they are usually soluble in drilling fluids, and give rise to enlarged boreholes. An infinitely resistive bed lying between shales may be recognized from the characteristic shape of the electric log resistivity curves, and the ratios of their readings. Any one of the curves may then be used to compute the borehole diameter, and hence decide whether the bed is salt.

Where a washed out salt bed is adjacent to another infinitely resistive bed in which the borehole is to gauge, the configuration of the curves is very characteristic. Apparent resistivity ratios again help to identify the salt.--Auth.

3-3700. Perkov, N.A. GEOPHYSICAL EXPLORATION OF CARBONATE RESERVOIR ROCKS: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 6-B, p. 372-373, 1959, pub. 1961.

It is recommended that a combination of standard electric logging, lateral logging, micrologging (gradient logging and potential logging), gamma-ray and neutron-gamma logging, and caliper logging be used when studying carbonate reservoirs for a correct appraisal of their porosity, degree of fracturing, and gas and oil content. Indications are given as to suitable methods of procedure.--C. Voûte.

3-3701. Lum, Daniel. THE RESISTIVITY METHOD APPLIED TO GROUND WATER STUDIES OF GLACIAL OUTWASH DEPOSITS IN EASTERN SOUTH DAKOTA: South Dakota, State Geol. Survey, Rept. Inv. no. 89, 44 p., 32 figs., incl. maps, graphs, 1961, 5 refs.

This report discusses the resistivity method in its application to problems of water-bearing glacial outwash deposits of sand and gravel in eastern South Dakota. The principles, field procedures, and methods of interpretation are discussed, particularly for the use of the Wenner configuration. The resistivity method for depth determinations of the glacial outwash deposits was limited by inaccuracy and unreliability of interpretations. The glacial deposits are believed to be too inhomogeneous and variable in lithology to permit correlation and interpretation of resistivity data except for very local and detailed investigations. Apparent resistivity field curves plotted on logarithmic graph paper with theoretical curve-matching interpretations and drill-hole control data from glacial deposits are presented for reference. The horizontal traverse method was found to be more useful than the depth-profile method in locating favorable sites for water test-wells by detecting and outlining outwash stream deposits and buried outwash channels in till. --Auth.

3-3702. Gudzin, Martin G., and Jack H. Hamilton. WICHITA MOUNTAINS SEISMOLOGICAL OBSERVATORY: Geophysics, v. 26, no. 3, p. 359-373, 19 figs., June 1961.

The Wichita Mountains Seismological Observatory is well equipped and is located at a site with a low background noise. Other instrumentation characteristics can be obtained by using different plug-in filters in the phototube amplifiers and by changing the natural period and coupling of the seismometers and galvanometers. Continuous spectrum analysis of noise and signals and detailed analysis of significant seismic events recorded on magnetic tape should prove very informative. The station is located at a convenient distance from Californian and Mexican earthquakes and should provide a significant contribution to the science of detecting and identifying underground nuclear explosions and earthquakes.--Auth. concl.

3-3703. Willmore, P.L. SOME PROPERTIES OF HEAVILY DAMPED ELECTROMAGNETIC SEISMOGRAPHS (In: Cook, A.H., and T.F. Gaskell, eds. The Earth Today: p. 389-404, 7 figs., table, New York, Interscience Publishers, 1961) 6 refs.

The classical theory of electromagnetic seismographs is discussed with special reference to the properties of combinations of seismometer and galvanometer in which the damping of either or both components in the system is very much greater than critical. The paper includes a graphical method of determining approximate response curves for such seismographs.

The treatment of passive systems is extended to cover cases in which the galvanometer light spot is made to energize a photoelectric amplifier, and in which the amplifier output is fed back into the mechanical system. It is shown that feedback into the galvanometer changes the apparent period or damping constant, but that such changes can only lead to types of seismograph which could, in principle, be constructed without the use of amplifiers. Feedback into the seismometer does, however, produce new effects. In particular it is shown that feedback proportional to the velocity of the galvanometer spot is equivalent to a change in the galvanometer reaction, such that the reaction constant λ may be given any desired positive or negative value. Large positive values of λ', in conjunction with large damping coefficients, lead to extremely wide-band characteristics. The argument is illustrated by experimental data on a seismograph constructed in Ottawa which yields an almost flat response to ground velocity from 0.5 s to 800 s period, and it is concluded that this pass-band could, if necessary, be extended by at least a decade at each end.--Auth.

3-3704. Linkov, E.M., and V.P. Tripolnikov. A MAGNETOELECTRONIC SEISMOGRAPH: Akad.

Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 164-165, 2 figs., 3 refs.

The magnetoelectronic seismograph, which is of a simple construction, has a high sensitivity that is not dependent on amplitude. This high sensitivity makes it possible to use the seismograph to transmit seismic signals by radio. The seismograph can be used for magnetic recording and for the electron-beam and galvanometric registration of seismic waves, as well as for measurement of tiltings of the earth's surface.--Auth. concl.

3-3705. Tullos, F.N., and L.C. Cummings, Jr. AN ANALOG SEISMIC CORRELATOR: Geophysics, v.26, no.3, p.298-308, 8 figs., June 1961, 5 refs.

An analog computer has been built to compute the cross-correlation coefficients of multi-trace seismograms. The evaluation program has shown that the computer has greater accuracy than is normally required to compute the cross-correlation functions of short samples of data. Points on the correlation curves are computed and plotted at the rate of approximately 50 points per minute. Scanning is in difference of arrival times (Δt) across the record, with increments of 1/2 to 16 millisecond. The correlation process is completely automatic with the exception of normalization, which is approximated by holding the total average signal power constant with a ganged attenuator. Analysis of synthetic and actual seismic data indicates that the correlation will be an interpretational aid in areas where the data are poor.--Auth.

3-3706. Cloud, William K., and Donald E. Hudson. A SIMPLIFIED INSTRUMENT FOR RECORDING STRONG MOTION EARTHQUAKES: Seismol. Soc. America, v. 51, no. 2, p. 159-174, 11 figs., table, Apr. 1961, 15 refs.

A strong-motion earthquake recorder for the direct measurement of one point on the response spectrum curve is described, and results obtained with the instrument under field conditions are compared with those obtained by a standard spectrum analysis of accelerograph records. The device has the advantages of low initial cost and of low maintenance expense, and can thus be installed in relatively large numbers. A network of such instruments located at points having various local geological conditions is proposed as a supplement to the U.S. Coast and Geodetic Survey strong-motion seismograph system.--Auth.

3-3707. Rykunov, L.N., and V.D. Feofilaktov. A PIEZOELECTRIC EMITTER OF SINGLE-STROKE ULTRASONIC PULSES FOR MODELLING SEISMIC WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 131-136, 9 figs., 5 refs.

It was found that the free vibrations excited in a pack of 45° Z-cut ammonium dihydrogen phosphate (ADP) plates by electric pulses are made up of 2 superimposed modes (ways of vibration) on different frequencies and causing different kinds of deformation of the plates. The characteristics of these deformations make it possible to eliminate one of the modes so as to produce an oscillator characterized by one natural frequency.

The vibrations excited in this oscillator by square electric pulses of varying duration were examined, and on this basis an emitter was designed to radiate elastic utrasonic pulses of various forms and, in particular, a single-stroke pulse.--Auth.

3-3708. Khalevin, N.I., and D.D. Barykin. AN INSTRUMENT FOR ACOUSTICAL INVESTIGATIONS IN BOREHOLES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 40-46, 7 figs., 10 refs.

A diagram of a station for the study of the variation in intensity of the dominant harmonic elastic waves in boreholes is described in this paper. It can be utilized in the generally accepted modification of seismic logging of average velocities. The first parameter is utilized in the study of the physical properties of rocks cut by the drill; the second is necessary for improving the accuracy of interpretation of seismic prospecting results. Examples of measurements in the boreholes are given.--Auth.

3-3709. Bolt, Bruce A. MACHINE PROCESSING OF SEISMIC TRAVEL-TIME DATA: Seismol. Soc. America, Bull., v. 51, no. 2, p. 259-267, diag., 5 tables, Apr. 1961, 12 refs.

A method of constructing empirical travel-time curves from a sample of observed times has been programmed for computation on a high-speed data processing machine. The method reduces to a uniform procedure analysis hitherto successful in obtaining the standard travel-time tables, and its speed of operation promises to facilitate the construction of regional tables. The program processes up to 500 observations of the phase under revision, taken from any number of selected earthquakes. The hypocenter and time of origin of each shock are first adjusted by an automatic procedure previously described and the needed correction applied to the observed times. The corrected times are then weighted relative to a provisional travel-time table, and the weights used to fit polynomials up to a specified degree. Sample characteristics are also computed to facilitate statistical treatment. Preliminary results, obtained using the program to process PKIKP times from 9 Aleutian shocks and a deep focus New Zealand shock, are presented. These results supply additional evidence that, relative to the standard P tables, J.-B. PKIKP times require the addition of about 1 1/4 sec.--Auth.

3-3710. Buffinton, P.G. EARTHQUAKE INSURANCE IN THE UNITED STATES - A REAPPRAISAL: Seismol. Soc. America, Bull., v. 51, no. 2, p. 315-329, 2 figs., 2 tables, Apr. 1961, ref.

The basic objective of this paper is to inform seismologists of some of the major problems which confront the earthquake insurance underwriter and to point out certain areas which are in need of further research and study.

The basic factors which are generally considered in making fire and other property insurance rates are discussed with special emphasis on their application in the earthquake insurance field.

The most important factor from the standpoint of earthquake insurance is the element of time or frequency of loss occurrence. In this connection a comparison is made of the fire and earthquake loss ratios for the period 1916-1957.

The earthquake experience by geographic zone in the United States is discussed and a table is presented showing the frequency of United States earthquakes for the period 1638 through 1956. The author points out that based on this information, it would appear that earthquake rates in the northeastern United States should be about 1/10 of the rates charged in California.

A comparison is also made of the average damage in dollars for earthquakes of various intensities, and a table is provided showing the results for earthquakes of intensity 7 and over on the Modified Mercali Scale.

The author concludes that the underwriter would be aided by more detailed information on individual earthquakes including specific information on the type of construction damaged, the type of ground upon which the building has been built, the total dollar damage and the estimate of property values in the high damage areas. Also needed is a further evaluation of the relation of intensity and frequency and better analysis of damage caused by earthquakes of various intensities.--Auth.

3-3711. Solovev, S. L. STATISTICAL DISTRIBUTION OF EARTHQUAKES AND TECTONIC STRUCTURE OF SEISMIC ZONES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 13-17, 4 figs., table, 10 refs.

The general conclusion of the paper is that no single parameter is sufficient for numerical characterization of the seismicity of an area. In order to answer the question how many and what parameters are required for such a characterization, it is necessary to make seismic observations by expeditions in different areas of the country and also to generalize the observations from stationary seismic stations which are being made during earthquakes within the boundaries of the U. S. S. R.--Auth. concl.

3-3712. Cameron, J. B. EARTHQUAKE IN THE NORTHERN CALIFORNIA COASTAL REGION (PART I): Seismol. Soc. America, Bull., v. 51, no. 2, p. 203-221, 6 figs., 10 tables, Apr. 1961, 16 refs.

The velocities of $\underline{P_n}$ and $\underline{S_n}$ phases are determined for earthquakes originating in the northern California coastal region. The existence of station delays at Shasta, Mineral, and Reno seismograph stations is proven for these earthquakes. A method of locating epicenters in this area is described, and epicenters for all large earthquakes since the installation of a station at Corvallis (1950), are found. A crustal structure consistent with observed data from these earthquakes is also presented.--Auth.

3-3713. Sanford, Allan R., and Charles R. Holmes. NOTE ON THE JULY 1960 EARTHQUAKES IN CENTRAL NEW MEXICO: Seismol. Soc. America, Bull., v. 51, no. 2, p. 311-314, 3 figs., Apr. 1961, 3 refs.

Earthquakes were felt in the Rio Grande valley of central New Mexico on July 22, 23, and 24, 1960. The strongest earthquake had a maximum intensity of 6 at La Joya. On the basis of 28 smaller shocks recorded on a 3-component seismograph at Socorro, an average epicenter of $34^{\circ}21.7'$N. and $107^{\circ}2.6'$W. was determined for the earthquakes. In addition to the direct $\underline{P}$ and $\underline{S}$ phases, the seismograms showed sharp phases approximately 0.35, 1.95, 5.50, and 7.80 sec. after the direct $\underline{P}$-phase.--Auth.

3-3714. Berg, Glen V., and George W. Housner. INTEGRATED VELOCITY AND DISPLACEMENT OF STRONG EARTHQUAKE GROUND MOTION: Seismol. Soc. America, Bull., v. 51, no. 2, p. 175-189, 13 figs., Apr. 1961, 4 refs.

The earthquake ground accelerations recorded at El Centro, California, Dec. 30, 1934; El Centro, May 18, 1940; Olympia, Washington, Apr. 13, 1949; and Taft, California, July 21, 1952, have been integrated with a digital computer to obtain at each location the 3 components of ground velocity and ground displacement. Maximum horizontal displacements of 10 and 20 in. are indicated, and maximum vertical displacements of 5 in. are indicated.--Auth.

3-3715. Eaton, Jerry P., and others. THE TSUNAMI OF MAY 23, 1960, ON THE ISLAND OF HAWAII: Seismol. Soc. America, Bull., v. 51, no. 2, p. 135-157, 12 figs., Apr. 1961, 9 refs.

The tsunami of May 23, 1960, originating in an area of profound crustal disturbance along the coast of Chile, resulted in the greatest natural disaster in Hawaii since the Aleutian-born tsunami of 1946. A study of $\underline{T}$ phases from earthquakes produced by this disturbance suggests that the duration of faulting responsible for the largest earthquake and the tsunami was about 7 minutes. With the exception of the Hilo Bay area, wave heights on the island of Hawaii were generally low, ranging between 3 and 17 ft., and averaging 9 ft. At Hilo, the third wave, which developed into a bore as it entered the bay, rose 35 ft. above sea level. The action of this bore is best explained in terms of a hydraulic shock wave; its relation to the tsunami wave train, however, is poorly understood. Patterns of wave heights on Hawaii's shores produced by recent tsunamis of diverse geographic origin are strikingly different, whereas those from nearly the same origin are remarkably similar. The city of Hilo, which experienced a loss of 61 lives and $20 million in property, sustained the most extensive damage.that occurred in the Hawaiian Islands. The need for tsunami research and continual public education, as a means for preventing further disaster, is painfully evident. The wave height data presented, together with the fullest possible evaluation of the seismogram, should aid in indicating danger areas and forecasting wave heights in future tsunamis.--Auth.

3-3716. Bullen, K. E. SEISMIC RAY THEORY (*In*: Cook, A. H., and T. F. Gaskell, *eds*. The Earth Today: p. 93-105, 2 figs., New York, Interscience Publishers, 1961) 10 refs.

Seismic ray theory is developed *ab initio* (apart from 1 or 2 standard elementary results) with special emphasis on the variables ζ and α, where $\zeta = \underline{d \log v / d \log r}$ and $\alpha = 2/(1-\zeta)$. Travel-time - distance relations are examined for a variety of types of velocity distribution, including the case α constant and cases where α and $\underline{v}$ change discontinuously, or rapidly but continuously, with increase of depth. The analysis is designed to provide an improved basis for working out in quantitative detail the effect on travel-times of the various types of velocity variation likely to be relevant to the earth. In particular, it is hoped that the analysis will lead to the most effective use of ray theory in the current difficult problems of the structure of the earth's outer mantle.

Advantage has been taken of the opportunity to present a number of previous results involving ζ and α in revised form, as part of a wider logical development. Previous work on deriving seismic velocity distributions from travel-time data is generalized.

The aim of the paper has been to set down a terse account of the basic theory, and no numerical applications have been included. References are given, however, to papers containing applications.--Auth.

3-3717. Caloi, Pietro. SEISMIC WAVES FROM THE OUTER AND THE INNER CORE (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 139-150, 8 figs., 2 tables, New York, Interscience Publishers, 1961) 14 refs.

New formulae for the determination of travel-times of seismic waves in the interior of the earth. Applications of said formulae to the calculation of travel-times of ScS-waves, recorded with exceptional clearness at Tolmezzo, on occasion of Aegean Isles shallow earthquakes (1957 Apr.-June). The problem of the waves reflected by the inner core: manifest examples of PKiKP-waves recorded at Tolmezzo.--Auth.

3-3718. Båth, Markus. POLARIZATION OF TRANSVERSE SEISMIC WAVES (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 106-123, 5 figs, 3 tables, New York, Interscience Publishers, 1961) 19 refs.

A theoretical investigation is made of the changes of the polarization of transverse seismic waves during their propagation through the earth. The polarizations have been computed theoretically and numerically for reflexion at the core boundary and at the earth's surface, for refraction and reflexion at the base of the crust and for passages through continuously varying media. It is demonstrated that great changes of the vibration properties (vibration angle and particle orbit) may occur in all cases except for continuously varying media, through which transverse waves propagate with practically unchanged vibration properties. The consequences of these results for earthquake mechanism studies, based on transverse waves, are discussed.--Auth.

3-3719. Rapoport, M. B. ON THE REFLECTION OF SEISMIC WAVES FROM NONSPECULAR BOUNDARIES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 118-124, 6 figs., 20 refs.

The structure of the wave field when a nonstationary (quasi-sinusoidal) wave from a point source is reflected on a nonspecular boundary is considered. The secondary diffracted waves that arise under certain conditions are propagated along the profile line with the dispersion of the phase velocity; this gives them special properties. These results have been confirmed by experiments on models of boundaries roughened at intervals. The secondary waves were isolated by laboratory use of the seismic method of variable directional reception (VDR). The results explain many of the features of the phenomena observed when using the VDR method in prospecting.--Auth.

3-3720. Stauder, William V., and W. Mansfield Adams. A COMPARISON OF SOME S-WAVE STUDIES OF EARTHQUAKE MECHANISMS: Seismol. Soc. America, Bull., v. 51, no. 2, p. 227-292, 9 figs., 3 tables, Apr. 1961, 8 refs.

Graphical and analytical techniques for using S-waves in focal mechanism studies are compared. In previous applications the analytical technique has shown little or no agreement with the results of fault-plane solutions from P-waves, whereas for other groups of earthquakes the graphical methods have shown good agreement between the S-waves and the P-wave solutions. It is shown that the graphical and analytical techniques are identical in principle and that when the graphical methods are applied to the same 3 earthquakes to which the analytical technique had been applied the identical results are obtained.

Closer examination of the graphical presentation of the data, however, shows that the disagreement between the S-waves and the fault plane solutions from P is largely apparent. The discrepancy follows upon the peculiar scatter in the S-wave data and the chance occurrence of observations of S at stations located along closely parallel planes of polarization of S. Once this is understood, it is seen that the direction of polarization of S-waves is in substantial agreement with the methods of analysis of focal mechanisms from P-waves, and that the data are consistent with a simple dipole as the point model of the earthquake focus. --Auth.

3-3721. Nuttli, Otto W. THE EFFECT OF THE EARTH'S SURFACE ON THE S WAVE PARTICLE MOTION: Seismol. Soc. America, Bull., v. 51, no. 2, p. 237-246, 4 figs., table, Apr. 1961, 12 refs.

This paper is concerned with the determination of the particle motion of the earth's surface due to the incidence of a plane S wave of arbitrary polarization and incidence angles. It is assumed that the earth's surface may be represented by a plane surface.

For angles of incidence less than $\sin^{-1}(b_o/a_o)$, where a_o and b_o are the P and S wave velocities at the earth's surface, all 3 components of ground motion will be in phase, and the resultant motion is linear. For angles of incidence greater than $\sin^{-1}(b_o/a_o)$, all 3 components of ground motion will in general be out of phase, with the resultant motion describing some 3-dimensional figure. The epicentral distance at which the motion changes from linear to nonlinear depends upon the wave length of the S wave and the slope of the travel time curve at that distance.--Auth.

3-3722. Lehmann, I. S AND THE STRUCTURE OF THE UPPER MANTLE (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 124-138, 4 figs., 2 tables, New York, Interscience Publishers, 1961) 22 refs.

The European as well as the northeastern American observations of S at small epicentral distances indicate the presence of a low velocity layer. In Europe its upper boundary seems to be at a depth of about 140 km. Since late S phases are observed at epicentral distances down to about 10^{o} there is likely to be an abrupt increase of velocity (as well as of velocity gradient) at the lower boundary of the layer at about 220 km. depth. Late S phases beyond 20^{o} can be accounted for if a further strong increase of velocity gradient at a greater depth is assumed.--Auth.

3-3723. Nuttli, Otto W., and John D. Whitmore. AN OBSERVATIONAL DETERMINATION OF THE VARIATION OF THE ANGLE OF INCIDENCE OF P WAVES WITH EPICENTRAL DISTANCE: Seismol. Soc. America, Bull., v. 51, no. 2, p. 269-276, 6 figs., 2 tables, Apr. 1961, 5 refs.

Apparent angles of incidence of the P wave were obtained from the seismograms of the Galitzin-Wilip instruments at Florissant. The "half-periods" of these waves varied from 1 1/2 to 3 1/2 sec. and the epicentral distances from 16.5^{o} to 103.2^{o}. The data indicate that the velocity of P waves at the earth's surface is approximately 8 km./sec. This suggests that these P waves do not see or are not affected by the earth's crust, although the crustal thickness is known to be approximately 35 km. P wave data from 5 other stations for the Alaska earthquake of July 1958 support the conclusions obtained from the Florissant data. --Auth.

3-3724. Belotelov, V. L., and N. V. Kondorskaya. **RELATIONSHIP BETWEEN EARTHQUAKE ENERGY AND MAXIMUM VELOCITY OF THE OSCILLATIONS IN BODY WAVES:** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 22-26, 3 figs., 2 tables, 8 refs.

The present paper examines the relationship between the energy of an earthquake, as determined by the authors, and the maximum oscillation velocity of the longitudinal and transverse waves. The energy values arrived at by the authors are compared with the energy values found for the same cases by means of the formulas given by Gutenberg. The energy differences of deep-focus and shallow earthquakes of equal magnitude are discussed.--Auth.

3-3725. Alterman, Z., and others. **PROPAGATION OF RAYLEIGH WAVES IN THE EARTH** (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 219-241, 11 figs., 11 tables, New York, Interscience Publishers, 1961) 14 refs.

The propagation of Rayleigh waves in the earth is investigated in the whole range of periods $\underline{T}$ from about 10 s. up to 1 hour. Three methods are necessary in order to cover this range of periods effectively. The standard flat earth method, with neglect of gravity, gives values for the phase velocity $\underline{C}$ correct to within 1% up to $\underline{T} = 50$ s. only, and for the group velocity $\underline{U}$ up to $\underline{T} = 250$ s. The method of the flattening of the earth, with neglect of gravity, has the 1% accuracy limits for $\underline{C}$ and $\underline{U}$ at 300 and 400, respectively. Inclusion of gravity effects in the flattening of the earth approximation does not alter the above limits. For $\underline{T} > 300$ ($\underline{n} < 25$) one must determine the period $\underline{T}(\underline{n})$ of free oscillation of the earth as a function of the order of the spherical harmonic $\underline{n}$. This involves the solution of a system of differential equations of the sixth order, in which the gravitational effects are included. The wave penetrates appreciably into the core already at $\underline{T} = 600$. Using the above 3 methods in their respective ranges of validity, we have evaluated $\underline{C}(\underline{T})$ and $\underline{U}(\underline{T})$ for 1) Bullen's Model B; 2) the Jeffreys-Bullen Model, as modified by Dorman, Ewing, and Oliver; and 3) the Gutenberg Model. The observed Rayleigh group velocity data of Ewing and Press for $\underline{T} < 380$ s. and phase velocity data of Nafe and Brune for $\underline{T} < 300$ s. agree with the values computed for the Gutenberg model, but not for the other models. This substantiates a previous conclusion reached by Takeuchi, Press, and Kobayashi and by Dorman, Ewing, and Oliver that the observed Rayleigh wave data provide evidence in support of Gutenberg's low-velocity layer. The few observed Rayleigh group velocities between $\underline{T} = 400$ and 600 are substantially lower than the theoretical values for all the 3 models.--Auth.

3-3726. Hochstrasser, Urs, and Robert Stoneley. **THE TRANSMISSION OF RAYLEIGH WAVES ACROSS AN OCEAN FLOOR WITH TWO SURFACE LAYERS, PART II: NUMERICAL** (In: Cook, A.H., and T.F. Gaskell, eds. The Earth Today: p. 197-201, 2 figs., New York, Interscience Publishers, 1961) 5 refs.

This investigation obtains values of the wave velocity and group velocity of waves of Rayleigh type, following ocean paths corresponding to the structures indicated by experimental investigations using explosions at sea. Eight different models have been considered, with ocean depths 4 or 6 km., a sedimentary layer of depth 1 or 2 km., underlain by basic rocks of thickness 5 or 7 km.; in all cases these structures were supposed to rest on ultrabasic rocks of great thickness.

The wave velocity was found for a series of values of the wave-number by solving an 11-row determinantal equation; the computations were performed by the use of the SEAC electronic computer of the U. S. National Bureau of Standards, and from these values the corresponding values of the group velocity were obtained by numerical differentiation. The general agreement of these dispersion curves with observed values indicates that they should be useful in determining the ray track and time of passage of a train of Rayleigh waves crossing an ocean floor whose structure and depth are varying from place to place. --Auth.

3-3727. Kovach, Robert L., and Frank Press. **RAYLEIGH WAVE DISPERSION AND CRUSTAL STRUCTURE IN THE EASTERN PACIFIC AND INDIAN OCEANS** (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 202-216, 6 figs., 5 tables, New York, Interscience Publishers, 1961) 13 refs.

Rayleigh wave dispersion data are presented for a number of earthquakes having their epicenters in the Easter Island area and which were recorded at Pasadena, California. The dispersion data differ in a small but significant way from those obtained for Pacific Ocean basin paths. When the seismic refraction data of Raitt are used to compute theoretical Rayleigh wave dispersion curves, discrepancies with the observed Easter Island-Pasadena data are found which are resolved by the addition to the assumed theoretical model of a modified low velocity zone in the upper mantle. This modification consists of lowering the mean shear velocity in the upper mantle to 4·5 km./s. It is further demonstrated that it is possible to have a theoretical model compatible with the compressional velocities obtained by seismic refraction measurements and the dispersion data which does not require changing Poisson's ratio from the usual value and consequent reduction of the shear velocities in the upper mantle. This is accomplished by reducing the thickness of the layer with compressional velocity 8·2 km./s. to the minimal thickness required to give a refraction arrival. The mean shear velocity of 4·5 km./s. implies a "soft" upper mantle along the Easter Island to Pasadena path. Dispersion data also show that the mean thickness of unconsolidated sediments between Easter Island and Peru is 0.57 km.

Rayleigh wave dispersion data are also presented for Indian Ocean shocks recorded at Wilkes Station, Antarctica. Within the limits of observational error, the Indian Ocean data are in agreement in the period range from 37 to 25 sec. with the theoretical model assumed for the Easter Island to Pasadena data.--Auth.

3-3728. Waldner, N. G., and E. F. Savarensky. **ON THE NATURE OF THE Lg_1 WAVE AND OF ITS PROPAGATION IN NORTHEAST ASIA:** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 1-12, 13 figs., table, 16 refs.

The presence is revealed of Lg and Rg waves in the NE. of the U. S. S. R. Their existence in the continental crust of the earth is demonstrated. The basic result of the work lies in the evidence based on the comparison of the observed and the theoretical data, that the Lg_1 wave may be the first or second overtone of a Love wave. The arrival of this wave is timed to the point of the maximum on the dispersion curve of the group velocity of the first and second overtones. --From auth., p. 1, 12.

3-3729. Takeuchi, Hitoshi, and N. Kobayashi. **FREE SPHEROIDAL OSCILLATIONS OF THE EARTH: Seismol. Soc. America, Bull., v. 51, no. 2, p. 223-225, 2 figs., table, Apr. 1961, 8 refs.**

Free periods of the earth's spheroidal oscillations are calculated for the wave numbers n up to 16. The earth's sphericity, self-gravitation, and a liquid core are taken into account. Period-wave number and period-phase velocity relations obtained are shown. --Auth.

3-3730. MacDonald, Gordon J. F., and Norman F. Ness. **A STUDY OF THE FREE OSCILLATIONS OF THE EARTH: Jour. Geophys. Research, v. 66, no. 6, p. 1865-1911, 29 figs., 21 tables, June 1961, 55 refs.**

Published observations on the toroidal oscillations of the earth are critically reviewed. A supplementary analysis of the record obtained by the Lamont strain seismometer is presented. Eleven toroidal modes are identified, and it is concluded that the periods are known to within 1%.

A perturbation scheme involving the ratio of the angular velocity of the earth to the resonant frequency is used in calculating the effects due to the rotation of the earth on the resonant frequency. The free oscillations are viewed as a superposition of traveling waves. In a nonrotating system 2 traveling waves combine to produce a stationary standing wave. In a rotating system, the rotation distinguishes between waves that travel in the direction of rotation and those that travel in the opposite direction. Rotation removes a degeneracy and results in a splitting of a spectral peak of order l into 2l+1 peaks. The fractional displacement in frequency for the lowest-order toroidal oscillations is 1/206 and of the same order as the Q of the peak, so that splitting will probably not be observed in the toroidal oscillations. Viewed locally, rotation causes a particle to precess about a direction parallel to the axis of rotation. This precession will cause a variation of amplitude with time if the motion is recorded by an instrument with an anisotropic response function. Care is therefore needed in studying the time decay of a given spectral peak. Rotation also couples the normal coordinates so that a motion that is initially purely horizontal will develop a vertical component. It is expected that vertical seismometers should record particle motion with the toroidal frequencies.

The perturbations of the toroidal oscillations due to core-mantle interaction are treated in detail. An exact expression is obtained for the rate of energy dissipated by a finitely conducting plate oscillating across a magnetic field. The energy dissipated at the core-mantle boundary due to viscous and hydromagnetic coupling is shown to be insignificant as compared with the energy dissipated within the mantle. The toroidal magnetic field leaking into the lower mantle combines with the dipole field, resulting in a stress on the mantle, tending to stiffen the lower boundary. The stress is of sufficient magnitude to produce a displacement toward higher frequency in the lower-order toroidal oscillations. Observations on the $_0T_2$ oscillations lead to an estimate of the toroidal magnetic field in the lower mantle.

A calculation of elastic energy in the low-order oscillations suggests a value of 10^{18} ergs/cph for the energy density at low frequencies in the Chilean earthquake. Each mode of oscillation has a characteristic radial distribution of elastic energy associated with it. This distribution determines which parts of the earth contribute most heavily in determining a particular resonant frequency. The distribution of energy for the lower 17 modes for a homogeneous and a Gutenberg model earth is calculated. The resonant frequencies for models of the earth based on the Gutenberg and Lehmann distribution of elastic properties are presented. It is shown that the Gutenberg model earth fits the observations more closely than the Lehmann model and that a slight alteration of the Gutenberg model gives a significantly better fit to the observations. The alteration involves a lower shear-wave velocity in the lower mantle while the Gutenberg velocity distribution is maintained in the upper mantle.

Various studies of the earth's oscillations coupled with surface-wave investigations substantiate Gutenberg's hypothesis of a layer of low velocity in the upper mantle. The physical conditions required for the formation of a region of low velocity are examined in detail. The results confirm Birch's earlier statement that a temperature gradient in excess of 6° to 7°/km. is needed to produce a decrease in velocity. The low-velocity layer does not require that the temperature approach or exceed the melting temperature. If the upper mantle is homogeneous, the region of lower velocity should commence at the base of the crust and extend to 150 km. under the oceans and about 100 km. under continental regions. The distribution of thermal conductivity and radioactivity consistent with the low-velocity layer is also considered.--Auth.

3-3731. Jobert, Nelly. **CALCUL APPROCHÉ DE LA PERIODE DES OSCILLATIONS SPHEROÏDALES DE LA TERRE [Approximate Calculation of the Period of Spheroidal Oscillations of the Earth] (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 242-258, 3 figs., New York, Interscience Publishers, 1961) 17 refs.; text in French.**

In the first part, spheroidal oscillations in the absence of gravitation are studied. The effect of the earth's core is considered, and the exact solution is obtained for a sphere with a homogeneous liquid core and a homogeneous solid mantle, having respectively the average properties of terrestrial core and mantle. By applying the principle of Rayleigh, following a method owed to H. Jeffreys, a value is found approximating the period of vibration for the model (A) of K. Bullen.

In the second part, attention is paid to forces of gravitation, the effect of which is studied on models of increasing complexity. By applying the Rayleigh principle, a value is obtained approximating the period of spheroidal oscillations for the models (A) and (B) of K. Bullen.--Auth., translated by A. C. Sangree.

3-3732. Takeuchi, Hitoshi. **TORSIONAL OSCILLATIONS OF THE EARTH (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 259-264, 4 tables, New York, Interscience Publishers, 1961) 5 refs.**

Making use of the variational calculus method developed in a previous paper, the free periods of torsional oscillations for 2 earth models are calculated. In Model 1, the earth is assumed to be composed of homogeneous mantle and core. In Model

2, the mantle structure model by Jeffreys and Bullen is used. In order to see dependence of the periods on the core rigidity, the periods when the core is fluid or perfectly rigid are calculated. In the fluid core model, periods are worked out when the coupling between the mantle and core is perfect or zero. The present study will show that in order to get useful information on the rigidity of the core or the strength of coupling between the mantle and core by this kind of study, observations of free periods with an accuracy of several 10 sec. must be made.--Auth.

3-3733. Peselnick, Louis, and Robert Meister. ACOUSTIC RELAXATION IN CHROMIUM: Jour. Geophys. Research, v. 66, no. 6, p. 1957-1961, 2 figs., June 1961, 10 refs.

Measurements in polycrystalline Cr of the temperature and frequency dependence of the ultrasonic velocities from -65 to +60°C and frequencies of 5 to 35 Mc/s were made. The attenuation associated with the dilatational wave was measured at 15 Mc/s from -25 to +25°C. Anomalies in the attenuation and velocity for the dilatational waves were found at -19°C. The compressibility and Poisson's ratio were calculated, and from these values the anomalous specific heat was determined. A dispersion in the dilatational velocity was found at -19°C., and, on the basis of a single relaxation process, the limiting high frequency velocity and relaxation time were estimated. From these calculations, a prediction of the magnitude of the attenuation was made and this agreed, within a factor of 2, with the measured attenuation.--Auth.

3-3734. Brune, James N., and others. THE POLAR PHASE SHIFT OF SURFACE WAVES ON A SPHERE: Seismol. Soc. America, Bull., v. 51, no. 2, p. 247-257, 4 figs., 2 tables, Apr. 1961, 13 refs.

It has been demonstrated by means of a model experiment that elastic surface waves on a sphere advance in phase by $\pi/2$ on each crossing of the polar or antipodal region. Comparison of the asymptotic forms of solutions of the wave equation for displacements and dilatation before the polar crossing with those that apply afterward also show the $\pi/2$ phase shift. Similarly a $\pi/4$ phase advance occurs for waves leaving a point source.

Because of the occurrence of the polar phase shift, it is necessary to correct previously published Rayleigh wave and Love wave phase velocities measured by correlation of phases over complete circumferential paths. The corrected Rayleigh wave phase velocity curve is presented here.

The polar phase shift is involved in the determination of periods of free oscillation of the earth from surface wave data. Using data from the great Chilean earthquake of May 22, 1960, it is shown that the ratio of the earth's circumference to the wave length at free oscillation periods gives very nearly half integers in accordance with the formula $2\pi a/\lambda = n + 1/2$.--Auth.

3-3735. Lapwood, E. R. THE TRANSMISSION OF A RAYLEIGH PULSE ROUND A CORNER (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 174-196, 6 figs., New York, Interscience Publishers, 1961) 11 refs.

Lamb, in his classical paper of 1904, found the form of the Rayleigh pulse that travels over the surface of an elastic half-space, which has been struck along a line. Let such a pulse travel on one face of an elastic quarter-space, the crest-line being parallel to and travelling towards the edge. We enquire what form the Rayleigh pulse will have after passing round the corner.

The problem is taken as 2-dimensional; the elastic solid fills the positive quadrant xOy and the incident Rayleigh pulse arises from a pressure $p(x,t) = -Q\delta(x-a)\phi(t)$ applied on the face $y = 0$.

The differential equations and boundary conditions are reduced to operational form by the use of a Fourier transform with respect to time and Laplace transforms with respect to x and y. Difficulties arise from our lack of knowledge of the displacements at the surfaces $x = 0$ and $y = 0$, but solution of the problem is reduced to that of 2 simultaneous integral equations.

An iterative solution can be found, and from this we isolate the parts which describe the incident Rayleigh pulse (identical with Lamb's solution) and the pulse transmitted round the corner.

It is found that the form of the pulse is greatly changed, in ways depending on the values of the velocities of P, S and Rayleigh waves. Whereas the displacements u and v on $y = 0$ have the shape of $\phi(t)$ and its allied function (Hilbert transform) $\phi'(t)$ respectively, each of u and v on $x = 0$ is given by a linear combination of ϕ and ϕ'. Since ϕ' may differ greatly from ϕ in form, the change in shape of each component of displacement when it turns the corner may be very marked.--Auth.

3-3736. Knopoff, Leon. GREEN'S FUNCTION FOR EIGENVALUE PROBLEMS AND THE INVERSION OF LOVE WAVE DISPERSION DATA (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 161-173, fig., New York, Interscience Publishers, 1961) 7 refs.

The change in the nature of the dispersion curve for Love waves has been determined for the case of a delta function inhomogeneity introduced at depth. The unperturbed medium is arbitrarily inhomogeneous in the depth dimension. It is shown that the perturbation in the dispersion curves due to a density inhomogeneity are decoupled from those due to a modulus inhomogeneity. Hence it is proved that any dispersion curve can correspond to an infinity of possible distributions of density and modulus; the relation between the possible solutions is given by a linear integral equation.

The inversion of the integral equations is carried out for the case when the starting values are those of the usual homogeneous layer overlying a homogeneous half-space. Hence from a given dispersion curve, the infinity of solutions are obtained as perturbations upon the assumed starting structure. The limitations of the inversion are discussed.--Auth.

3-3737. Steinhart, John S., and Robert P. Meyer. EXPLOSION STUDIES OF CONTINENTAL STRUCTURE [With Contributions by W. E. Bonini, T. Jefferson Smith, and G. P. Woollard]: Carnegie Inst. Washington, Pub. 622, 409 p., maps, secs., profiles (2 in pocket), diags., graphs, tables, 1961, approx. 300 refs.

The study of crustal structure of the continents by the observation of seismic waves generated by explosions is in principle the most precise method of measuring the physical properties and structure of the crust. Past results have often been difficult to reconcile with commonly accepted theories. In particular, the mechanism of isostasy was not clear from the observations. The measurements reported were made in the following areas, selected for their gravity anomalies and tectonic associations: Mexico - a high plateau, with a large negative Bouguer gravity anomaly; Arkansas - a slightly positive cratonic element with positive Bouguer anomalies; Wisconsin - a shield area characterized by both positive and negative Bouguer anomalies; eastern Montana - the margin of a mountain system with large negative Bouguer anomalies; and the Rocky Mountains of western Montana.

Methods of data reduction and model selection were reviewed and programmed for solution on a high speed computing machine so that all plausible models that fit the data could be computed. Statistical analysis was developed that permitted the estimation of minimum uncertainty for the crustal model calculated. This uncertainty is a minimum in the sense that the scatter of the observations makes the uncertainty at least as large as the calculated estimate. Amplitudes were studied, and it was determined that, at present, the use of absolute amplitude data is hampered by inadequate knowledge of the response of the ground-geophone system. It was found that this and other difficulties could be eliminated by the study of amplitude ratios. Accordingly, the theory was developed to calculate theoretical amplitude ratios for the crustal models that were considered. Comparison of these values with the observed amplitude ratios offered a valuable criterion for acceptance or rejection of plausible models. As part of the theoretical amplitude studies, it is shown that p_1 ($\bar{p}$) cannot be transmitted as a critically refracted wave because the observed amplitudes are much too large. The travel times for the velocity gradient observed by Birch for pressure increase on granite were calculated and found to correspond to the observations. Theoretical amplitudes for this type of gradient exhibit very small amplitudes at some distances that might be measured.

Simple and multiple regression analyses were performed on 73 explosion seismic determinations of crustal structure taken from the literature and this report. It was found that only the mean crustal velocity and the Bouguer anomalies are significantly related linearly to crustal thickness. There is some indication that geologically corrected isostatic anomalies are also so related, but values were not available in enough areas for an adequate test. The crustal models reported from the U.S.S.R. were shown to be widely at variance with evidence from all other sources. The difficulty was traced to failure by Russian workers to use measured velocities to calculate depths. From the results of this analysis it is strongly suggested that in certain areas the Pratt type of isostatic mechanism is important.--Auth.

3-3738. Hudson, Donald E., and others. GROUND ACCELERATIONS CAUSED BY LARGE QUARRY BLASTS: Seismol. Soc. America, Bull., v. 51, no. 2, p. 191-202, 9 figs., 2 tables, Apr. 1961, 13 refs.

Ground acceleration-time measurements have been made within 2,000 ft. of 2 quarry blasts of total charge weight 185 tons and 673 tons. Ground accelerations were of a character and magnitude similar to those associated with damaging earthquakes. Complete response spectrum curves calculated from the acceleration records are presented. Direct comparisons are made between these results and previous similar measurements and calculations using identical instruments, which have been made of strong-motion earthquakes, H. E. blasts, and the Rainier nuclear blast. --Auth.

3-3739. Voskresensky, Yu. N. SOME TYPES OF DIFFRACTED WAVES DETECTED BY THE ADJUSTABLE DIRECTIONAL RECEIVER METHOD (ADR): Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 125-130, 7 figs., 13 refs.

As a result of operations using the ADR method in Bashkiriya new data are obtained on the recording of the $P_{12}P_{21}$ and $P_{112}P_{21}$ type waves which develop as a result of diffraction of nonhomogeneities in the shallow occurring rigid interlayer (caused by the distortion) and returning to the shot point. The $P_{12}P_{21}$ and $P_{112}P_{21}$ waves possesses equal apparent velocities, which follow with a small time interval Δt and create oscillations of considerable duration. These waves superimposed on useful reflected waves were one of the reasons for creating complicated seismic recording.

As the experiments indicated, the accurate separation of these waves can be accomplished by utilizing the spectra of the superimposed oscillations.

The separation of the $P_{12}P_{21}$ and $P_{112}P_{21}$ waves in this region is determined by applying the ADR method with its specific separating ability. The results of field recordings show good agreement with theoretical data and geological considerations in the region of operations.

A further application of the ADR method will permit separating the $P_{12}P_{21}$ and $P_{112}P_{21}$ type waves more frequently and utilize them in geological interpretations.--Auth. concl.

3-3740. Gassmann, Fritz. SOLUTION OF AN n-LAYER PROBLEM BY A SEISMIC REFLECTION METHOD (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 151-157, fig., New York, Interscience Publishers, 1961) ref.

The treatment of the n-layer problem presented in this paper is based on the assumption that the subsoil is bounded by a plane surface and that plane interfaces of arbitrary position subdivide the subsoil into homogeneous isotropic solid layers.

In Sec.1 recursion formulae are derived for wave-rays which are reflected by one interface and refracted by the others. It is shown in Sec. 2 that a parametric representation of the travel-time function can be found for an arbitrary position of the point source. Sec. 3 deals with the computation of the travel-time for a given position of a seismometer. The method is based on successive approximations using a Taylor expansion of the travel-time. In Secs. 4 and 5 a method is presented to compute the front velocities and the positions of the interfaces in the subsoil on the basis of suitable seismic reflection measurements.--Auth.

3-3741. Ogurtsov, K. I. THE IMPROVEMENT OF ACCURACY IN ASYMPTOTIC APPROXIMATIONS FOR THE INTENSITY OF WAVES PROPAGATED IN A LAMINATED ELASTIC MEDIUM: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 142-145, 11 refs.

For short intervals of time including the instant when a front arrives at the point of observation, the known exact solution is in the form of a series. In the present paper, an approximate solution is obtained by retaining the first 2 terms of this series (previously only one term was retained). The conditions for which the second term may not be neglected are investigated. The formulas obtained are simplified for the case when the direction of propagation of certain of the seismic waves is inclined at a small angle to the interface. A method of simplification is pointed out for the case when the direction of propagation of the waves can be inclined at a small angle to the normal.--Auth.

3-3742. DeNoyer, John M. **THE EFFECT OF VARIATIONS IN LAYER THICKNESS ON LOVE WAVES: Seismol. Soc. America, Bull., v. 51, no. 2, p. 227-235, 5 figs., Apr. 1961, 6 refs.**

A model is considered in which Love waves propagate perpendicular to the trend of a structure that is varying in thickness as a sine function of distance. The period equation for this model is obtained, and average values for phase and group velocities are found for several distance ranges. A method is proposed for finding relative amplitudes as a function of position along the structure for any specified period. --Auth.

3-3743. Roznichenko, Yu. V. **THE SCATTERING OF REFLECTION-REFRACTION SEISMIC WAVES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 552-554, 2 figs., May-June 1959, pub. 1960, ref.**

The problem of estimating the maximum depth at which reflection seismic surveying is possible has some similarities to the problem of measuring water transparency by means of the Secchi disc. Because of the nature of the seismic waves, however, different methods are required for the solution of the problem. The degree of transparency of the covering media can be characterized by the ratio of the intensity of the singly reflected wave to the total intensity of the incident multiply reflected-refracted scattered waves. In addition to the parameters of the medium itself, the angle of incidence and the frequency of the vibrations of the seismic impulse must be considered. --F. Manheim.

3-3744. Richards, T. C. **MOTION OF THE GROUND ON ARRIVAL OF REFLECTED LONGITUDINAL AND TRANSVERSE WAVES AT WIDE-ANGLE REFLECTION DISTANCES: Geophysics, v. 26, no. 3, p. 277-297, 18 figs., 2 tables, June 1961, 18 refs.**

The horizontal and vertical motions of the surface of the ground on the arrival of reflected longitudinal and transverse waves from an elastic discontinuity are determined theoretically, with special reference to those parameters encountered in exploring for limestone structures in the foothills of western Canada by wide-angle reflection techniques. The results, which cover a wide range of possible overburden velocities, are expressed by means of curves from which the displacement for any practical elastic contrast, depth, and observation distance may be readily determined. Properties of these curves are examined empirically. The theory assumes plane waves in determining the amplitude ratios at the structural or free surface discontinuities and spherical waves in deriving spread factors. Corrections to the curves on account of a nonuniform overburden velocity are considered in the case of a typical central foothills well. The evidence for PP and PS in model, and to a less extent in field work and the significance of phase changes on reflection are discussed. It is concluded that the horizontal geophone should prove to be a useful additional tool in wide-angle reflection surveys in disturbed foothills zones. Here, it could confirm or refute the arrival of a reflection registered by the vertical geophones in the many cases where doubt exists.--Auth.

3-3745. Ballakh, I. Ya., and M. F. Mirchink. **THE POSSIBILITY OF USING SEISMIC EXPLORATION FOR THE DIRECT DETERMINATION OF OIL AND GAS DEPOSITS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 566-567, May-June 1959, pub. 1960, 3 refs.**

The gas and oil content of rock influences its density, the velocity of elastic vibration passing through it, its resistance to seismic waves, and changes the coefficient of reflection of the boundaries of the gas-oil strata. Calculation of the order of magnitude of the coefficient of reflection of soil-water interfaces shows that reflections from these surfaces in many cases will be recorded on seismographs. The present preliminary study indicates that it may be possible to use seismic methods for the direct mapping of oil and gas deposits.--F. Manheim.

3-3746. Birch, Francis. **THE VELOCITY OF COMPRESSIONAL WAVES IN ROCKS TO 10 KILOBARS, PART 2: Jour. Geophys. Research, v. 66, no. 7, p. 2199-2224, 3 figs., 15 tables, July 1961, 92 refs.**

The measurements of the velocity of compressional waves up to 10 kilobars for some 250 specimens of rock, reported in part 1 [GeoScience Abstracts 2-1500], are discussed with respect to the effects of porosity, alteration, anisotropy, and composition. The relations of isotropic elasticity are shown to be approximately valid for a number of examples. Reasonable agreement with theoretical values for quasi-isotropic aggregates is demonstrated where comparison is possible. At pressures above a few kilobars, the principal factors determining velocity are density and mean atomic weight; oxides and silicates conform to the same general relations, with a few exceptions. Details of symmetry or crystal structure appear to be of secondary importance. Velocity is an approximately linear function of density for materials having a common mean atomic weight, but is in general not a single-valued function of density alone.--Auth.

3-3747. Birch, Francis. **COMPOSITION OF THE EARTH'S MANTLE (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 295-311, 5 figs., 7 tables, New York, Interscience Publishers, 1961) 37 refs.**

Measurements of the velocity of compressional waves in silicates and oxides having a range of density from 2·6 to 5 g./cm.^{3} suggest a simple dependence of velocity upon density and mean atomic weight. Consequences of the assumption that this relation remains valid at high pressures are examined with reference to the composition of the mantle, especially of the transition layer. It appears probable that the abnormally high rate of increase of velocity with depth in the transition layer may be accounted for principally in terms of phase change, with little change of composition. Recent studies with strong shock waves are examined in connection with the composition of the core; the evidence is unfavourable to the hypothesis of a metallic core of light elements, but is consistent with a core of Fe alloy.--Auth.

3-3748. Hales, A. L. **A WEAK LAYER IN THE MANTLE (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 312-319, 2 tables, New York, Interscience Publishers, 1961) 14 refs.**

The paper discusses the effect of a weak layer in the upper mantle on the deformation of the crust arising from atmospheric loading, and on the isostatic compensation process. It also points out that S phases with periods of 1 sec. are much more strongly damped than S phases with periods of 10 sec. or more, and than P phases with short periods. The damping arising from a liquid layer is proportional to the square root of the frequency and does not provide a satisfactory explanation. Scattering of the kind suggested by Jeffreys, or any other mechanism leading to the firmoviscous law, gives rise to damping proportional to the square of the frequency and is sufficiently frequency sensitive to be consistent with the observations. The differences between P and S can only be accounted for in terms of different behavior of the elastic constants for dilatational and distortional movements.--Auth.

3-3749. Tryggvason, Eysteinn, and Markus Båth. UPPER CRUSTAL STRUCTURE OF ICELAND: Jour. Geophys. Research, v. 66, no. 6, p. 1913-1925, 4 figs., 10 tables, June 1961, 10 refs.

This report contains the results of the seismic measurements made by a Swedish-Icelandic expedition in Iceland during the months of Aug. and Sept. 1960. This is a continuation of work started a year earlier and is the first detailed investigation of the deeper structure of the lava beds on Iceland. Measurements were made at 8 locations, each with a refraction profile from 20 to 41 km. long, in order to obtain values on thickness and structure of the lava layer which covers the whole island. The profiles were laid near a line in a SW.-NE. direction across central Iceland. The lava layer was found to consist of 3 sections with longitudinal wave velocities of 3.7 ± 0.3, 4.95 ± 0.2, and 5.55 ± 0.05 km./sec. The 3.7-km./sec. section was found mainly in SW. Iceland, where the other 2 sections were not found. In N. Iceland the 4.95-km./sec. section was found near the surface and the 5.55-km./sec. section at a depth of about 2 km. The total lava thickness ranges from 1.73 to 4.81 km.; it is thin in the SW. and thick in the northern part of Iceland. Below the lava layers, the longitudinal wave velocity is about 6.2 km./sec. increasing to 6.7 km./sec. at a depth of about 5 km. Shear waves were clearly recorded on 3 profiles in N. Iceland, but were recorded not at all or only faintly on other profiles.--Auth.

3-3750. Averyanov, A. G., and others. DEEP SEISMIC SOUNDING IN THE ZONE OF TRANSITION FROM THE ASIAN CONTINENT TO THE PACIFIC OCEAN DURING THE IGY: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 109-117, 13 figs., 12 refs.

The investigated area of transition, from the point of view of structure of the earth's crust, is complex and variegated. Crust of the continental type, consisting of 3 layers - sedimentary, "granitic," and "basaltic" - is found in the region of the northern islands of the Kuril Island arc and below the adjacent shallow-water parts of the ocean (as far as the deep-water basin), as well as between the southern islands of the arc and the deep-water basin. The total thickness of the crust in the various sectors is uneven, but remains for the most part within 20-30 km.

In the northern and central parts of the Sea of Okhotsk the structure of the earth's crust is more uniform and is composed predominantly of a granitic layer. It may be assumed that above the M boundary there lies a thin layer with an increased velocity (a basaltic layer), the roof of which, apparently, corresponds to a soft seismic boundary without any velocity discontinuity, and therefore the refracted waves, related to the basaltic layer, are not manifested here sufficiently clearly.

Oceanic-type crust, consisting of a thin sedimentary layer (up to 1 km.) and a basaltic layer 5 to 12 km. thick, has a total thickness of 10 to 17 km., including the layer of water (about 5 km.). Crust of this type is noted eastward of the Kuril-Kamchatka deep-water trench, in the area of the oceanic plateau. Near the islands oceanic crust is observed in the central portion of the arc, at Simushir island.

Crust of the transitional type differs from continental-type crust in that it is impossible to isolate any granitic layer with a velocity of 6 km./sec. within superbasaltic thickness, and from oceanic-type crust in that the thickness of the superbasaltic layer here is comparable in thickness to the basaltic layer in the ocean. The mean velocity values in this layer indicate its predominantly sedimentary contents. Crust of this type is noted in the deep-water part of the Sea of Okhotsk, below the central and southern islands of the Kuril arc, below the Kuril-Kamchatka trench, as well as in Bering Sea and in the ocean near Komandorskiye islands. The total thickness of the transitional-type crust varies within the limits of 10 to 20 km.

The region of the Kuril Island arc and of the deep-water basin, where staggering of crust of all 3 types is found, is particularly noteworthy. The crust of the Kuril Island arc and the adjacent shallow-water part of the Pacific Ocean is of nonuniform structure. The area of maximum depths of the M boundary in this zone is located to the E. of the line of islands. The area of minimum depths is located in the central part of the arch and adjacent part of the Pacific Ocean. In this region there appears to be present a junction between the ocean and the deep-water part of the Sea of Okhotsk, where crust of the transitional type is also observed. The earth's crust in the northern part of the Kuril arc to the N. of Onekotan island is of the continental type.--From auth. concl.

3-3751. Kogan, S. D., and others. SEISMIC OBSERVATIONS IN ANTARTICA [SIC]: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 2, p. 146-149, 6 figs., table, 5 refs.

This paper presents the results of seismic observations from the Soviet seismic stations in Antarctica (Mirny and Oazis) from June 1956 to Dec. 1959. A comparison of the earthquake epicenter distribution with the geologic structure of the sub-Antarctic is given. From the dispersion curves of Love and Rayleigh waves it was concluded that the earth's crust is of continental type in eastern Antarctica and of oceanic type in the area that extends from Antarctica to the belt of Alpine-type fold structures encircling the polar continent.--Auth.

3-3752. Schrader, C. D., and R. J. Stinner. REMOTE ANALYSIS OF SURFACES BY NEUTRON-GAMMA-RAY INELASTIC SCATTERING TECHNIQUE: Jour. Geophys. Research, v. 66, no. 6, p. 1951-1956, 10 figs., 2 tables, June 1961, 6 refs.

Reversing the procedure of a number of year's work in the determination of the cross sections for production of γ rays by 14-Mev neutrons interacting in pure elements, we have been studying the feasibility of applying our techniques to the remote chemical analysis of unknown materials. We have measured the spectra of γ rays produced by neutrons in a large sandpile containing various known percentages of the elements O, Mg, Al, Si, and Fe. A general statement can be made that a 5% abundance of any of these elements can be quantitatively determined to a precision of better than 10%. The method, using fast gating and timing circuits to select only the γ rays originating unambiguously from the neutron inelastic scattering process, appears so promising that a miniature, pulsed accelerator is now being tested and packaged. Applications to the analysis of the lunar surface, planetary atmospheres, and the earth's crust and mantle are discussed.--Auth.

3-3753. Solomasov, A. N. INTERPRETATION OF NEUTRON-GAMMA LOGS FOR DETERMINATION OF THE OIL-WATER CONTACT IN UNPERFORATED WELLS: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 6-B, p. 374-378, 3 figs., 1959, pub. 1961, 5 refs.

The paper discusses, with the aid of examples taken from the Tuymazy oil field (Gashkivia), the factors which govern the changes in secondary gamma radiation during the carrying out of neutron-gamma logs. These changes do not depend only upon the Cl content of the formation, but also upon the diameter of the borehole to a maximum of 45 cm., the effective range of penetration of the neutron-gamma log being 44 cm. Moreover composition and porosity of the reservoir rocks and the presence or absence of circulation behind the casing also influence the readings. Therefore logging can only be carried out successfully under specified conditions of uniformity, and even in that case it only permits a distinction between oil-water-bearing beds from oil-bearing ones. It is not possible to make a quantitive determination of the water in the oil.--C. Voûte.

3-3754. Bunker, Carl M. GAMMA-RADIOACTIVITY INVESTIGATIONS AT THE NEVADA TEST SITE, NYE AND LINCOLN COUNTIES, NEVADA: U. S. Geol. Survey, Trace Elements Inv. Rept. 778, 95 p., 52 figs. (3 in pocket), 2 tables, 1961, 9 refs.

Measurements of gamma radioactivity in tunnels and drill holes at the Nevada Test Site were made to determine quantitatively the natural radioactivity of geologic formations and to determine the distribution of explosion-produced radioactivity in the vicinity of nuclear explosions. Tunnel walls were surveyed with portable scintillation detection equipment, and drill holes were logged with Geiger-Mueller and scintillation detectors. These measurements were started in 1957 and were completed in Feb. 1960.

Natural radioactivity was measured in alluvium and in 8 units of the Oak Spring formation (tuff), marble, dolomite, and granite. The highest radioactivity was observed in granite; the lowest radioactivity was in marble and dolomite. Radioactivity in alluvium is related to the amount of cementation; the radioactivity is highest where cementation is lowest. Drill-hole logs generally show 1) contacts between rock types by changes in radioactivity at the contacts, 2) location of the water level in the drill holes, and 3) location of casing. Radioactivity surveys in the tunnel systems seldom show contacts between the types of tuff penetrated by the tunnels.

Drill holes in a waste disposal area were gamma-ray logged before and after a part of the area was flooded with a water-borne radioactive tracer. The logs showed that most of the tracer accumulated at the lower end of the area and that movement was confined to a distance less than 4 ft. from the tile through which the tracer flowed.

Measurements in the vicinities of the Rainier and Neptune nuclear explosions show that explosion-produced radioisotopes are distributed in nearly hemispherical configurations. Radioisotopes produced by the Rainier explosion are concentrated in 2 nearly concentric hemispheres below the explosion point and are associated with radioactive glass.--Auth.

3-3755. Jacobs, J. A. SOME ASPECTS OF THE THERMAL HISTORY OF THE EARTH (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 267-275, 2 figs., New York, Interscience Publishers, 1961) 31 refs.

A number of thermal problems connected with the earth are discussed - the early thermal history of the earth and some of its consequences, the formation and state of the inner core, convection in the core and its relation to the earth's magnetic field, and conditions in the upper mantle.--Auth.

3-3756. Verhoogen, John. HEAT BALANCE OF THE EARTH'S CORE (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 276-281, table, New York, Interscience Publishers, 1961) 13 refs.

It is shown that the heat necessary to maintain convection in the core may come from slow cooling and crystallization of the core with corresponding growth of the solid inner core. The present rate of cooling would be of the order of 10°-45° per 10^9 years, depending on temperature.--Auth.

3-3757. Bullard, E. C., and A. Day. THE FLOW OF HEAT THROUGH THE FLOOR OF THE ATLANTIC OCEAN (In: Cook, A. H., and T. F. Gaskell, eds. The Earth Today: p. 282-292, 4 figs., 2 tables, New York, Interscience Publishers, 1961) 9 refs.

Fifteen measurements of the heat flow through the ocean floor have been made in the Atlantic and one in the Mediterranean. One measurement in the central valley of the Mid-Atlantic ridge gives a heat flow of 6.5 μcal./cm.^{2}s. Similar very high values have been found by others on the crest of the East Pacific rise. The possibility that these high values represent the rising limb of a convection current is discussed. The mean of the remaining 15 values and of 5 from a previous investigation, give a mean heat flow of 1.06 ± 0.055 μcal./cm.^{2}s which is very close to the mean for all measurements in the Pacific, excluding those on the East Pacific rise.

The equipment has been modified so that the temperature gradients in the whole probe and in its lower half can be determined separately. The lower half gives a value 8.8% above that for the whole probe; the reason for this is not known.

The thermal resistivity of ocean sediment, R, is found to be a linear function of the water content, w (in percent water of the wet weight). At the temperature of the ocean floor the relation is R (cms deg C./cal.) = $(168 \pm 14) + (6.78 \pm 0.31)w$.--Auth.

7. GEOCHEMISTRY

See also: Geophysics 3-3747; Igneous and Metamorphic Petrology 3-3826; Mineral Deposits 3-3863, 3-3864, 3-3867.

3-3758. Brown, N. L., and B. V. Hamon. **AN INDUCTIVE SALINOMETER: Deep-Sea Research, v. 8, no. 1, p. 65-75, 7 figs., 2 tables, June 1961, 10 refs.**

The inductive salinometer is an instrument for measuring the salinity of sea water to an accuracy of approximately 0.003 parts per mille. The instrument is portable and does not require a temperature-controlled bath for the samples. The general design and operation of the instrument are described, and test results are summarized.--Auth.

3-3759. Wlotzka, Frank. **UNTERSUCHUNGEN ZUR GEOCHEMIE DES STICKSTOFFS [Investigations on the Geochemistry of Nitrogen]: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 106-154, 10 figs., tables, June 1961, 89 refs.; text in German, abs. in English.**

Two methods for the determination of combined N in rocks and minerals are described:

1) Determination of total combined N by decomposition of the rock by fusion with NaOH in a closed system, and solution of the melt in water. By this method of decomposition a part of the existing NH_3 is oxidized to NO_3; therefore it is impossible to determine NH_3 and NO_3 separately. The NO_3 is reduced by Devarda's alloy to NH_3, which is distilled off with the primary NH_3, adsorbed in a standard acid, and determined colorimetrically by the Nessler method.

2) Determination of NH_3-N and NO_3-N separately by decomposition of the sample with hydrofluoric acid at 90° C. in a closed polyethylene bottle, neutralization of the acid with NaOH, and distillation and determination of the NH_3 as under 1). After that determination of NO_3 as NH_3 by reduction by Devarda's alloy.

In both methods the NH_3 can be determined with an accuracy of 10%, for amounts less than 10 ± 1 g./ton. The error of the NO_3 determination is 25% and the sensitivity is 5 g./ton.

In 400 rock and mineral samples NH_3-N and NO_3-N were determined mainly by the second method. Besides this the water-soluble N was determined in all magmatic rocks and minerals. The results show that nearly all magmatic rocks contain NH_3-N, ranging between 5 and 50 g./ton, of which approximately one-half is water-soluble. There exists no characteristic difference between the different groups of rocks. Some rocks, which are not fully degassed, contain more NH_3 than the average, up to 150 g./ton. The average content of magmatic rocks is 20 g. NH_3-N/ton. NO_3-N was not found.

The distribution of the NH_3-N between the different minerals of a rock was determined by separation of some granites, granodiorites and a basalt into their mineral constituents. Muscovite and biotite are richest in NH_3-N (average of 60 and 33 g./ton), feldspars contain less (20 g./ton), and quartz least (13 g./ton). Late-magmatic minerals such as zeolites are higher in NH_3-N than the rocks in which they occur, and the same is true for hydrothermally altered minerals (chloritization and sericitization).

The distribution of the NH_3-N between the different magmatic rocks and minerals and the presence of water-insoluble NH_3-N in nearly all magmatic rocks leads to the conclusion that the NH_3-N is of primary magmatic origin.

The existence of nitrides in rocks is discussed and is considered to be improbable.

The NH_3-N content of sedimentary rocks is higher than in magmatic rocks. Clays and clayslates contain in the average 580 g. NH_3-N/ton, sandstones 135 g./ton and limestones 70 g./ton. Several series of sediments show that the NH_3-content is dependent on the content of micas and clay minerals.

NO_3-N was found in minute amounts (5-20 g./ton) in surface sediments, some saline clays, and in limestones. Average clays and sandstones contain no NO_3-N.

Metamorphic sediments contain much less NH_3-N than the unaltered rocks. The NH_3-N content of paragneisses and orthogneisses is variable, but in the average paragneisses contain more NH_3-N than orthogneisses.

Finally the average NH_3-N content of the lithosphere is estimated.--Auth.

3-3760. Ostrovsky, I. A., and others. **THE P-T DIAGRAM OF THE SYSTEM SILICA-WATER: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 587-588. 2 diags., May-June 1959, pub. 1960, 4 refs.**

Experimental P-T diagrams of the silica-water system are given. One of the new features of the diagrams is the negative slope of the conversion curve of tridymite-cristobalite. Neither cristobalite nor tridymite appear to be stable at high pressures. Despite earlier views, quartz may coexist with liquid at temperatures above 1,300° C. An application of this finding may be that in deep magmatic centers quartz may form at temperatures considerably above 850°C. --F. Manheim.

3-3761. Barnes, H. L. and Gunnar Kullerud. **EQUILIBRIA IN SULFUR-CONTAINING AQUEOUS SOLUTIONS, IN THE SYSTEM Fe-S-O, AND THEIR CORRELATION DURING ORE DEPOSITION: Econ. Geology, v. 56, no. 4, p. 648-688, 17 figs., 7 tables, June-July 1961, 91 refs.**

The thermodynamic relations between partial pressures and molecular or ionic activities of aqueous solutions containing S are presented graphically as functions of the 5 variables: T, P, pH, P_{O_2}, and (ΣS) (the total activity of aqueous S species). These diagrams provide a quantitative basis for correlation of the composition of aqueous solutions to the fields of stability of minerals up to 250°C. The correlation is based on the principle that at equilibrium, partial pressures fixed at any one temperature by a univariant assemblage of minerals in an anhydrous system are not affected by the addition of H_2O if the assemblage is unchanged.

The application of this principle to the anhydrous Fe-S-O system demonstrates that up to 250°C. the common assemblage pyrite, pyrrhotite, and magnetite may be deposited at equilibrium only by alkaline ore solutions. This assemblage has been deposited in nature and is stable in the dry system over a temperature range from 675° to below 250°C.

The association of sphalerite with pyrrhotite, pyrite, digenite, covellite, and barite, but not with free S, limits thermodynamically the aqueous conditions during deposition. At 250°C. this ore solution must be neutral to weakly alkaline with HS^- as the predominant S-containing aqueous ion; P_{S_2} is usually between $10^{-8.5}$ and $10^{-14.7}$ atm. and P_{O_2} between 10^{-36} and 10^{-50} atm. Therefore, the solubility of sphalerite must be sufficient to account for the transport required for ore formation at 250°C. under the conditions where pH=7.5, $P_{O_2}=10^{-40}$ and $(\Sigma S)=1.0$ m.--Auth.

3-3762. Duffy, J. Regis, and others. SOLUBILITY OF NATURAL GASES IN AQUEOUS SALT SOLUTIONS — I. LIQUIDUS SURFACES IN THE SYSTEM CH_4-H_2O-$NaCl_2$-$CaCl_2$ AT ROOM TEMPERATURES AND AT PRESSURES BELOW 1000 PSIA: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 23-31, 5 figs., 4 tables, June 1961, 9 refs.

The solubility of methane in water, in aqueous solutions of sodium chloride, calcium chloride, and both sodium and calcium chloride has been determined at room temperatures and at pressures up to 1,000 psia by the pressure decline method. The results for water agree with previous published values, but the solubilities in the salt solutions are considerably higher. The data obtained, augmented by other solubility figures from the literature, permit the construction of the liquidus surfaces in the tetrahedral phase model for the system CH_4-H_2O-NaCl-$CaCl_2$ at fixed temperature and pressure. An orthogonal projection of these surfaces is presented.--Auth.

3-3763. Kuroda, P. K. THE TIME INTERVAL BETWEEN NUCLEOSYNTHESIS AND FORMATION OF THE EARTH: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 40-47, 2 tables, June 1961, 20 refs.

The differences (δ_i) in the abundance ratios of the stable Xe isotopes in meteorites and in the earth's atmosphere indicate that the latter contains an excess of fissiogenic Xe. It is postulated that the "extinct" transuranium elements, such as Pu^{244} and Cm^{247}, played important roles in the production of the fissiogenic Xe in the earth's atmosphere. The time interval (Ξ) between the nucleosynthesis and the formation of the earth has been calculated from the values of δ_i. If it is assumed that the contribution from the Cm^{247} spontaneous fission and the U^{235} neutron-induced fission was negligible, a value of Ξ = 4.8×10^8 years is obtained for the single event model and a value of $\Xi = 0.52 \times 10^8$ years for the continuous synthesis model.--Auth.

3-3764. Altschuler, L. V., and S. B. Kormer. ON THE INTERNAL STRUCTURE OF THE EARTH: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1961, no. 1, p. 18-21, 2 figs., 15 refs.

Comparison of the speed of sound in Fe at high pressures with the velocity of seismic waves confirms Bullen's hypothesis that the inner core is solid. Comparison of the $v_p(p)$ and C_{Fe} (p) curves supports the idea that the inner core is chemically homogeneous. To settle its chemical composition (Fe-Ni or heavier elements) we must determine the Poisson's ratio of Fe and Ni for pressures of 3-3.5 million atm.

The densities of Fe and Ni for the pressures in the outer core (1.4-3.2 million atm.) do not coincide with Bullen's density distributions and do not lie within the Rado-Molodenski limits at the boundary of the outer core. The percussive compressions of 2.3 million atm. in olivine do not produce more dense phases.

If further studies fail to reveal the required phase transitions in silicates, preference must be given to the theory that the core consists of the oxides and sulfides of Fe with a considerable content of free metals.--Auth. concl.

3-3765. Jastrow, Robert, and Gordon J. F. MacDonald. HIGHLIGHTS OF THE PLANETARY SCIENCES PROGRAM: Am. Geophys. Union., Trans., v. 41, no. 3, p. 430-434, Sept. 1960.

In a program (Apr. 1960) arranged by the Planning Committee on Planetary Science, American Geophysical Union, it was pointed out that if the apparent youth of stony meteorites compared with Fe meteorites (tens of millions versus hundreds of millions of years) depended upon their being buried for a time beneath the moon's surface and so protected from cosmic ray-induced tritium, the cosmic ray ages of both become so uncertain as to remove the previous discrepancy in age. An examination of the Hamlet chondrite showed Ar-37 (35 days half life) 3 times as high as it should be compared to Ar-39 (260 years half life); based on the assumed space path this would indicate that the intensity of cosmic radiation decreases with increasing distance from sun.

Unexpectedly intense radio emission (15 to 35 megacycles) from Jupiter was interpreted as produced by electrons trapped above the atmosphere by a magnetic field, which, however, could not be produced by an internal convection field (as assumed on earth) because the estimated temperature gradient is inadequate to drive a convection current.--A. C. Mason.

3-3766. Lipschutz, Michael E., and Edward Anders. THE RECORD IN THE METEORITES – IV. ORIGIN OF DIAMONDS IN IRON METEORITES: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 83-105, 8 figs., 5 tables, June 1961, 71 refs.

A number of diamond-bearing Canyon Diablo specimens have been investigated in order to determine whether the diamonds were produced under high gravitational pressures in a meteorite parent body, or upon impact with the earth, as proposed by Urey and Nininger, respectively. Metallographic studies confirm Nininger's observation that the diamond-bearing fragments, and only these, were reheated strongly after the formation of the Widmanstätten pattern. The metal phase appears to have been reheated to $\sim 950^oC$. for 1-5 sec., followed by cooling in less than 2 min. The rapid cooling rate implies that the process took place after the meteorite fragments had attained their present, small size.

Thermodynamic calculations and structural studies indicate that cohenite (Fe_3C) rather than graphite is the likely precursor of diamonds in Fe meteorites. This fact severely limits the possible range of conditions for diamond formation. The diamonds are always associated with troilite, which shows signs of having been heated to much higher temperatures than the metal, suggesting that the heating took place by a shock wave upon impact with the earth. The growth of diamonds must have occurred on cooling or pressure drop, but it is not yet clear whether high pressures (e.g. from the compression during impact shock, or localized stresses) were at all required, or whether the diamonds formed as a metastable product at moderate to low pressures.

Possible origins of diamonds in other meteorites are discussed. It is shown that in the presence of free Fe, formation under high gravitational pressures could take place only under very extraordinary circumstances. Instead, it is considered much more likely that all meteoritic diamonds were produced by catastrophic events, either upon impact with the earth, or during the breakup of the meteorite parent bodies. This mode of origin obviates the need for postulating meteorite parent bodies of lunar or planetary size, with interior pressures of 3×10^4 atm. or greater.

The laboratory formation of diamond is discussed in terms of metal carbide dissociation equilibria, and several features of the General Electric process are explained in this manner. Some comments are offered on Moissan's experiments.--Auth.

3-3767. Stauffer, Heinz. PRIMORDIAL ARGON AND NEON IN CARBONACEOUS CHONDRITES AND UREILITES: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 70-82, fig., 5 tables, June 1961, 22 refs.

The abundance and isotopic composition of Ar and Ne in 5 carbonaceous chondrites and in 2 ureilites have been measured. The results show that these meteorites contain large amounts of trapped primordial gases. Heating experiments with only partial extraction of the rare gases have been carried out, showing that at 950° K the radiogenic Ar diffuses out more readily than the primordial Ar, and cosmogenic Ne at about the same rate as primordial Ne. From that it is concluded that the primordial gases are enclosed within the matrix of the crystal lattice.

Ar-K ages and Ne^{21} exposure ages have been calculated. Both are affected by diffusive losses. Only Felix has an Ar/K age of 4.5 AE (billion years).

A large loss of primordial Ar and Ne as compared to the Si is observed. The loss of primordial Ar is constant within a factor 10 for all samples, and about 10 to 100 times smaller than the loss observed for the earth. The ratios of primordial Ne^{20} to primordial Ar^{36} have values between 0.005 and 22, indicating large fractionation between Ar and Ne as compared to the corresponding cosmic ratio. Fractionation by diffusive losses is discussed. Some deviations of the isotopic ratios of primordial Ar and Ne from the atmospheric ratios are observed.--Auth.

3-3768. Fireman, E. L., and G. A. Kistner. THE NATURE OF DUST COLLECTED AT HIGH ALTITUDES: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 10-22, 4 illus., 9 tables, June 1961, 21 refs.

Dust was collected from the atmosphere at altitudes above 40,000 ft. by devices mounted on airplanes or balloons. The spatial density of the dust particles larger than 3 microns varied from less than 1 per 5 cu. m. to 12 particles per cu.m. The particles appeared to be present in the form of dust clouds. Individual particles were analyzed for the elements, Fe, Ni, Co, Mn, Cr, Cu, and Zn with an electron-probe microanalyzer, and for Al and Co by neutron activation. Sixty-five specimens were analyzed. Most particles contained from 0.1% to 90% Fe while some contained Cu, Zn, or Mn in addition. None had detectable amounts of Ni, Co, or Cr. An upper limit of 30,000 tons per year for the entire earth was obtained for the accretion rate of particles between 3 and 30 microns in size with an Fe-Ni-Co ratio similar to that of meteorites. Many of the particles could represent possible terrestrial contamination, but this explanation is improbable for the Fe-Mn particles.--Auth.

3-3769. Hunter, W., and D. W. Parkin. COSMIC DUST IN TERTIARY ROCK AND THE LUNAR SURFACE: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 32-39, 2 figs., 2 tables, June 1961, 16 refs.

The remains of cosmic spherules have been found in 2 samples of Tertiary rock from the Oceanic formation on Barbados. Only the outer oxide coating of the Fe cosmic spherules is preserved. It is supposed that weathering has corroded the metallic nucleus usually found within the Fe spherule, and the absence of olivine spherules is attributed to the same cause.

If it is assumed that cosmic dust has been falling throughout geological time at much the same rate as now, then a thick uniform blanket should overlay the level surfaces of the moon, obscuring all fine detail. Over some of these regions the expected monotony is not apparent. An attempt is made to remove the difficulty by supposing that meteorites have accompanied the dust. The impacts of the meteorites continually blast out fresh lunar rock, the fragments being exposed to erosion by the dust. The large amount of powdered rock so produced completely smothers the cosmic dust, and the composition in any locality is much the same as the underlying rock.--Auth.

3-3770. Barth, Tom. F. W. ABUNDANCE OF THE ELEMENTS, AREAL AVERAGES AND GEOCHEMICAL CYCLES: Geochim. et Cosmochim. Acta, v. 23, no. 1/2, p. 1-8, 3 tables, 1961, 10 refs.

The Rosenbusch system, which regards igneous rocks as primary and sedimentary rocks as ultimately derived from igneous rocks, still governs modern geochemical thinking. A major discrepancy in this concept is the fact that igneous rocks contain about 3 times as much Na as sedimentary rocks. Goldschmidt thought that the missing Na is found in the sea and based his estimation of the total amount of weathered rock on this assumption.

If one regards Na, as well as all other elements, as having a certain passage time through the ocean, an entirely different picture will be found. The amount of weathered rock will then apply only to the passage time of Na through the ocean, or ca. 200 million years. Assuming that weathering and sedimentation have been restricted to the continents and their shelves, it is calculated that a total erosion corresponding to a depth of more than 60 km. must have taken place in the continents. This would mean that practically all continental rocks were once sediments which have been changed by metamorphism, metasomatism, and remelting under plutonic conditions, and again raised to the surface to become sediments.

No firm elemental abundance data are possible until the areal abundance of various types of rocks on the earth is compiled.--F. Manheim.

3-3771. Shcherbina, V. V. FACTORS DETERMINING THE GEOCHEMICAL DISTRIBUTION OF SCANDIUM: Geokhimiya, in translation, 1959, no. 8, p. 882-886, pub. 1961, 13 refs.

Sc is a typical lithophylic trace element. The noticeable irregularity of its distribution in rocks and minerals is caused by its typically lithophylic properties of the relatively strong base which is able to accumulate in the pegmatite-hydrothermal stage, impoverished in Mg and Fe compounds and enriched in anions (e. g. wolframate, niobate ions) which are Sc precipitators.

Sc does not participate in redox processes, and in coals it accumulates not at the expense of reduction but of sorption.

Sc participates more intensively in the formation of complex compounds than the rare earths which increases its migration ability.

The irregularity of the Sc distribution in silicate minerals is caused by the energy values of the crystal lattice.--Auth.

3-3772. Borisenko, L. F. ON THE DISTRIBUTION OF SCANDIUM IN IGNEOUS ROCKS ON THE EXAMPLE OF SOME MASSIFS OF THE SOVIET UNION: Geokhimiya, in translation, 1959, no. 7, p. 770-777, 5 tables, pub. 1961, 26 refs.

The results of an investigation of Sc distribution in a number of intrusive massives of the Soviet Union have shown that: 1) Higher Sc contents are typical for ultrabasic and basic rocks (~ 0.003% of Sc_2O_3) and lower contents for intermediate (0.0005 of Sc_2O_3) and acid rocks (~0.0002% of Sc_2O_3). 2) The character of FeO, MgO, and Sc_2O_3 distribution in rocks of the ultrabasic type bears witness of a more probable geochemical bond of Sc and divalent Fe. Pyroxenites are characterized by the highest Sc_2O_3 content (up to 0.017%).--Auth.

3-3773. Ovchinnikov, L. N., and others. RETENTION OF ARGON IN MICAS: Geokhimiya, in translation, 1959, no. 8, p. 874-881, 2 figs., 2 tables, pub. 1961, 5 refs.

The article gives the results of studying the preservation stage of Ar in hydrated biotites as well as of the mode of extracting Ar from them at different temperatures. It has been established that the hydration of biotite does not influence the preservation state of Ar in it under natural conditions. At the same time, being heated, the hydrated Ar isolates (loses) the chief mass of Ar at considerably lower temperature than the nonhydrated biotite, and the higher the hydration degree, the greater this loss.--Auth.

3-3774. Amirkhanov, Kh. I., and others. THE MIGRATION OF ARGON AND HELIUM IN CERTAIN ROCKS AND MINERALS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 394-395, 3 figs., May-June 1959, pub. 1960, ref.

Simultaneous measurement of the diffusion of Ar and He in carbonaceous shale, hornblende, and pyroxene were carried out. In hornblende and pyroxene the diffusion coefficients of He and Ar were equal. This indicates that the migration of the gases is not due to the nature of the gases themselves. In carbonaceous shales a difference in diffusion rate was found for Ar and He. It is concluded that only samples which have been checked for retention of radiogenic gases should be used for age determination by the Ar and He methods.--F. Manheim.

3-3775. Gerasimovsky, V. I., and others. ON THE GEOCHEMISTRY OF NIOBIUM AND TANTALUM IN THE LOVOZERO ALKALIC MASSIF: Geokhimiya, in translation, 1959, no. 7, p. 803-812, graph, 2 tables, pub. 1961, 10 refs.

In the nepheline syenites of the Lovozero massif (Kola peninsula, U. S. S. R.) Nb and Ta are concentrated in minerals which contain Ti and Zr and isomorphously replaces these elements in them. In the process of formation of rocks of the massif, which, compared to other types of magmatic rocks, is enriched in Nb and Ta, a separation of Nb from Ta does not occur. The Nb-Ta ratio for nepheline syenites is the same (~12) for different intrusive phases. An increase of Ta with respect to Nb is not even observed in rocks considerably enriched in Zr. Towards the end of the magmatic process an accumulation of Nb and Ta takes place; their relative concentration compared to Ti increases simultaneously. --Auth.

3-3776. Turekian, Karl K., and Michael H. Carr. CHROMIUM, COBALT AND STRONTIUM IN SOME BUREAU OF STANDARDS ROCK REFERENCE SAMPLES: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 1-9, fig., 5 tables, June 1961, 10 refs.

A method for the simultaneous determination of Cr and Co in rocks by neutron activation is described, and results on a set of rock reference samples supplied by the U. S. National Bureau of Standards are reported. Sr was also determined in the same materials by an emission spectrographic method calibrated by isotope dilution determined standards. It is suggested that National Bureau of Standards reference materials be used for interlaboratory comparisons and checks of accuracy.--Auth.

3-3777. Marshall, Royal R., and Oiva I. Joensuu. CRYSTAL HABIT AND TRACE ELEMENT CONTENT OF SOME GALENAS: Econ. Geology, v. 56, no. 4, p. 758-771, 2 figs., 3 tables, June-July 1961, 24 refs.

Galenas from the Upper Mississippi Valley district, the Picher field, and the southwestern United States were analyzed for a number of trace elements by emission spectroscopy. Quantitative determinations of Ag, Bi, Cu, and Sb are reported here for most of the 31 samples. The samples varied in crystal habit from simple cubes through mixed forms to octahedrons. The concentrations were found to vary widely from one mineralized area to another; but within a given district, crystals of cubic habit are systematically enriched in Sb compared to those of octahedral habit. No progressive change in either the Ag or the Bi content with crystal habit was observed. Particularly large concentrations of some of the trace elements, however, did occur in some of the deposits in which octahedral faces were especially prominent. Both the trace element content and the crystal habit appear to be symptomatic of other factors involved in the formation of galena. Temperature is probably one of the most important factors; the cubic form seems to predominate at the lowest temperatures.--Auth.

3-3778. Komarova, G. N., and L. E. Novorossova. BEHAVIOR OF TIN AND INDIUM IN THE COLLOFORM AGGREGATES OF CASSITERITE FROM THE DZHALINDA DEPOSIT OF MALYY KHINGAN: Geokhimiya, in translation, 1959, no. 8, p. 887-892, illus., table, pub. 1961, 7 refs.

On the basis of the chemical investigations it was established that cassiterite collomorph aggregates of the Dzhalinda deposit contain some acid saturated Sn, not associated with S. It was discovered that in cassiterite collomorph aggregates In is found in the form of various independent compounds. Some In compounds are easily soluble in mineral acids (H_2SO_4, HCl) whereas the others are stable. The authors suppose that acid stable In compounds are In-As minerals and easily soluble ones are oxidic minerals.--Auth.

3-3779. Brooks, R. R., and L. H. Ahrens. THE DETERMINATION OF INDIUM AND THALLIUM IN G-1, W-1, AND OTHER SILICATE ROCKS BY A NEW TECHNIQUE: Geochim. et Cosmochim. Acta, v. 23, no. 1/2, p. 145-147, 2 tables, Apr. 1961, 18 refs.

In and Tl were determined in G-1, W-1, and other silicates by chemical extraction followed by quantitative spectrochemical analysis. The results for G-1 and W-1 are 1.27 and 0.21 p.p.m., respectively. For a number of the rocks a relationship between Mn and In is apparent.--F. Manheim.

3-3780. Zhabin, A. G., and G. N. Mukhitdinov. A HYPOGENE AUREOLE OF RARE-EARTH DISSEMINATION ABOUT THE VISHNEVOGORSK-ILMEN

MOUNTAINS MIASKITE INTRUSION (SOUTHERN URALS): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 490-491, May-June 1959, pub. 1960, 6 refs.

As a result of the intrusion of miaskites (nepheline-biotite syenites) an exogenic aureole is found in the metasomatically altered country rocks; this aureole was found enriched in a number of rare-earth minerals such as allanite, chevkinite, eschynite, bastnäsite, britholite, monazite, thorianite, betafite, and niobo-eschynite. Rare earths are also present in sphene and apatite. Within the miaskite intrusions themselves only individual specimens of mangan-orthite, monazite, and eschynite were found. The occurrence is compared with aureoles surrounding alkalic complexes in other areas such as those of central Tataria and the Kola peninsula.--F. Manheim.

3-3781. Mookherjee, Asoke. DISTRIBUTION OF MINOR ELEMENTS IN THE GONDITIC MANGANESE ORE AND ITS GEOCHEMICAL SIGNIFICANCE: Econ. Geology, v. 56, no. 4, p. 723-729, fig., table, June-July 1961, 7 refs.

Nearly 200 partial or complete analytical data, collected by Fermor, and a few partial analyses by the author, have been utilized in studying the pattern of distribution of the minor elements in the gonditic type of ores from Nagpur, Chhindwara, Bhandara, Balaghat, Jhabua, and Narukot areas, India. Apart from Fe, Al, and Si, which may be regarded as major constituents in most of the ores, P, Ba, Ca, Mg, Na, K, Ni, Co, Ti, S, As, Pb, Zn, and Cu have been detected. The gonditic ores are found to be characterized by: 1) variable amount of P increasing with increased amount of Fe, 2) preponderance of CaO over MgO, 3) preponderance of K_2O over Na_2O, 4) preponderance of CoO over NiO, 5) ubiquitous BaO, markedly concentrated in hollandite and psilomelane.

The data of other constituents are too meager to be relied on. However, Pb, Zn, Cu, and Ti appear to be concentrated in ores rich in psilomelane. No direct conclusion can be made regarding the behavior of S and As.

This pattern of distribution can be very well explained if we assume that colloidal processes were operative in the formation of these ores. The minor elements were adsorbed on the colloidal particles, some by chemisorption, some by Van dar Waals adsorption. The cations like Ba^{2+}, Na^+, K^+, Mg^{2+}, Ca^{2+}, Ni^{2+}, Co^{2+}, Ti^{4+}, Zn^{2+}, Pb^{2+}, etc. were adsorbed by $Mn(OH)_4$ sols, which are (-ve)ly charged, and anions like $SO_3^{=}$, AsO_4^{3-}, $PO_4^{\equiv}$ were attached to ferric hydroxide sols, which are positively charged. Amongst the cations, high CaO:MgO, $K_2O:Na_2O$, and CoO:NiO ratios can be explained by lower ionic potentials (and therefore higher adsorbability) of Ca^{2+}, K^+, and Ni^{2+} compared to those of Mg^{2+}, Na^+ and Co^{2+} respectively.

It is therefore tentatively suggested that the solution, which caused alteration of the gondites into ore, held Fe, Mn, Si and Al as colloidal oxides and hydroxides particles and not in ionic solution. The varying concentrations of the electrolytes, the positively charged SiO_2 and $Mn(OH)_4$ particles, and the negatively charged $Fe(OH)_3$ and $Al(OH)_3$ particles in different parts of the deposits caused partial or complete flocculation in certain places by neutralization, and at other places stabilized the colloidal solution. Such a hypothesis offers better explanation for some other features of the ore.--Auth.

3-3782. Solodov, N. A. GEOCHEMISTRY OF RARE-METAL GRANITE PEGMATITES: Geokhimiya, in translation, 1959, no. 7, p. 778-792, graph, 5 tables, pub. 1961, 24 refs.

According to the rock-forming minerals 4 types of rare-metal pegmatites are distinguished. Type 1 - microcline pegmatites, type 2 - albite-microcline pegmatites, type 3 - albite pegmatites, type 4 - albite-spodumene pegmatites.

The content of alkaline and rare elements in these types is not always similar, usually ranging in rather narrow limits in well developed veins of the same types. The following elements are characteristic of the different types: type 1 - K, Be; type 2 - K, Na, Ta, Be, Cs, Rb, Tl, Li; type 3 - Na, Li, Be, Ta, Nb, Sn; Type 4 - Na, Li, sometimes Nb, Sn. The formation of the different types and the different degree of their enrichment by alkaline and rare elements may be explained by the initial geochemical specificity of the pegmatite melts.--Auth.

3-3783. Gipp, S.K. TITANIUM IN THE BAUXITES OF THE KAIRAK DEPOSIT: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v.126, no. 1-6, p.411-414, 4 figs., table, May-June 1959, pub. 1960, 6 refs.

The Kairak bauxites [Central Asia] have formed on Paleozoic chloritized volcanic rocks and consist of oolitic-pisolitic diaspore cemented with chlorite. Titanium (TiO_2) is present in concentrations of from 1 to 1.5% in the upper part of the weathering crust, 2.5-3.5% in the bauxites and approximately 5% in the pisolites themselves. The Ti is chiefly in the form of leucoxene (microcrystalline anatase) and is believed to have participated with Al in the formation of the oolites during the initial diagenetic stages.--F. Manheim.

3-3784. Dobrovolsky, V. V. MINOR ELEMENTS IN THE CARBONATE CONCRETIONS FROM THE QUATERNARY DEPOSITS OF THE ARID ZONE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 403-404, 2 tables, May-June 1959, pub. 1960, 13 refs.

Chemical and semiquantitative spectrochemical analyses of minor elements in 68 carbonate concretions from soil-supergene environments were reported. The carbonate was chiefly cryptocrystalline calcite with 0.35-1.70% MgO. The following concentrations were found in the HCl-soluble fraction: SiO_2, 1.65-3.73%; Al_2O_3, 0.21-2.08%; Fe_2O_3, 0.20-2.41%; Na_2O + K_2O, 0.10-1.45%. Ti is always found in traces. Of the minor elements determined spectrographically Sr was enriched 2 to 3.5 times over concentrations in the host rocks of the concretions, while V, Cu, Pb, Ni, Co, Ba, Ga, Li, Zr, Sn, Yb, Sc, La, Y, Ag, and Be were detected but occurred in lower concentrations than in the host rocks. The concentration of Cr was approximately the same in concretions and host rocks. --F. Manheim.

3-3785. Zubovic, Peter, and others. GEOCHEMISTRY OF MINOR ELEMENTS IN COALS OF THE NORTHERN GREAT PLAINS COAL PROVINCE: U. S. Geol. Survey, Bull. 1117-A, 58 p., 3 figs., pl. (in pocket), 14 tables, 1961, 108 refs.

Twenty-six channel or auger samples and 195 blocks of coal from 25 columnar samples were analyzed for some or all of the following minor elements: Be, B, Ti, V, Cr, Co, Ni, Zn, Cu, Ga, Ge, Mo, Sn, Y, and La. B, Ti, Sn, Y, and La were not looked for in some of the early analyses.

A study of the variations exhibited by the elements vertically within a bed shows that in some beds the variation between most of the elements is almost identical whereas for others it is completely heterogeneous. The large degree of variation for most of the elements in adjacent blocks shows a lack of a secondary redistribution of these elements. There also is a positive correlation for most of the elements with increases in clastic matter in the coal as shown by the ash content of the coal.

A comparison of series of the minor element content beds in stratigraphic intervals does not indicate any secondary enrichment either from the leaching of overlying formations or by hydrothermal or other activity. Comparison of the amounts of these elements in the coals with that found in present day plants shows that most of these elements can be accumulated by plants in the amounts found in coal. All of these factors indicate that the accumulation of these elements in the coal was a syngenetic process.

Anomalous amounts of some of these elements were found in kettlebottom coals and the coalified trees lying above the coal beds. The genetic differences of these samples as compared to those of bedded coal as well as the stabilities of metal-organic complexes of these metals are used to explain the disparity of the minor element content of these special types of samples and that of bedded coal.--P. Zubovic.

3-3786. Volkov, I.I. FREE HYDROGEN SULFIDE AND IRON SULFIDE IN MUD SEDIMENTS OF THE BLACK SEA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 396-398, fig., 2 tables, May-June 1959, pub. 1960, 13 refs.

The concentration of free hydrogen sulfide and the concentration and form of iron sulfide in stagnant Black Sea muds were studied. Free H_2S was driven out of freshly obtained cores by means of N, taken up in cadmium acetate solution and determined iodometrically. H was not satisfactory as the carrier gas. Values ranging from 0.00004 to 0.0004% free H_2S in the natural mud were found.

Distillation of the mud with added water in a stream of CO_2 resulted in half of the sulfide S in the sediment being liberated. It was therefore assumed that the iron sulfide in the sediment was in the form of hydrotroilite, corresponding to a composition of $FeS \cdot H_2S$. --F. Manheim.

3-3787. Ostroumov, E. A., and L. S. Fomina. ON THE FORMS OF SULFUR COMPOUNDS IN THE BOTTOM DEPOSITS OF THE MARIANAS TRENCH: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 405-407, fig., table, May-June 1959, pub. 1960, 8 refs.

Sulfate, sulfide, free S, pyritic S, and organically combined S were determined in bottom sediments of the Marianas trench. Sulfate was chiefly restricted to the interstitial water of the oozes and decreased downward in the profile as a consequence of reduction of sulfate to hydrogen sulfide. Iron sulfide (hydrotroilite) fluctuates strongly and is found enriched in certain layers. The hydrotroilite reacts with free S to form pyrite and marcasite. As a result, hydrotroilite and pyrite curves tend to be a mirror image of each other during the early diagenetic period. A parallel but less pronounced tendency for free S and organic matter to form organically bound S was also reported.--F. Manheim.

3-3788. Oborn, Eugene T., and John D. Hem. MICROBIOLOGIC FACTORS IN THE SOLUTION AND TRANSPORT OF IRON: U. S. Geol. Survey, Water-Supply Paper 1459-H, p. 213-235, 6 illus., 8 tables, 1961, 23 refs.

Amounts of Fe dissolved by distilled water from soil, sand, and mixtures of organic matter with soil and sand were determined before and after 2 weeks of incubation at temperatures from 35° to 100°F. Amounts of Fe present in solution were from about 1 to 8 p.p.m. (parts per million) after incubation at 72° or 100°F. After incubation at 35° or before incubation, only a few tenths of a part per million or less were present. Amounts of Fe in solution were generally much larger when organic matter was mixed with the soil than when soil or sand alone was used. The amounts of Fe brought into solution sometimes exceeded the amount available in the organic matter added. The organic matter consisted of pulverized dried plant leaves and stems, mostly aquatic species, and manures of 3 species of herbivorous animals.

The increase in amount of Fe leached from soils after incubation is related to microbiologic activity. Organic complexes of Fe aid in retaining in solution the Fe made available by the microbiota. By helping to bring Fe into solution, microbiota influence the Fe content of surface and ground water in many areas. --Auth.

3-3789. Baranov, I. V. BICARBONATE COEFFICIENTS IN WATERS OF CERTAIN RIVERS OF THE USSR: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 572-573, 3 tables, May-June 1959, pub. 1960, 3 refs.

Bicarbonate coefficients refer to the ratio of HCO_3 ion to total cations and anions in the water. River waters from moist regions generally have bicarbonate coefficients of 0.5-0.70. In water of rivers flowing into the southern seas the coefficients tend to be lower than 0.50, and decrease with distance from the mouth to the source. Streams flowing into arid regions and interior basins have the lowest coefficients of all. In addition to the higher mineralization, a loss of bicarbonate is effected by precipitation of calcium carbonate from the water.--F. Manheim.

3-3790. Votintsev, K. K., and N. V. Verbolova. THE EFFECT OF SEICHE PHENOMENA AND BODY WAVES ON THE HYDROCHEMICAL REGIME IN LAKE BAIKAL: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v.126, no. 1-6, p. 408-410, 2 figs., 2 tables, May-June 1959, pub. 1960, ref.

Studies of the daily changes in concentration of O_2, NO_3, and free CO_2 were carried out in lake Baikal. No regular daily variation in these components could be observed, either with depth or time. However, it was found that sharp changes in concentration, particularly in nitrate of the surface waters, were found over short periods of time. It is considered that seiches and body waves may be responsible for these phenomena.--F. Manheim.

3-3791. Baranov, V. I., and L. A. Khristianova. RADIOACTIVITY OF THE WATERS OF THE INDIAN OCEAN: Geokhimiya, in translation, 1959, no.7, p. 765-769, 2 figs., table, pub. 1961, 9 refs.

A direct determination of U content in some tens of water samples of the Indian Ocean has been carried out. It is found that the U content in the central areas of the ocean averages $1.8 \cdot 10^{-6}$ g. /1.

In the southwestern part the content is somewhat higher ($1.0 \cdot 10^{-8}$ g./1.). By calculation the concentrations of Th ($1.0\cdot10^{-8}$g./l.) and of ionium ($6\cdot10^{-13}$ g./l.) have been estimated for water in the central part of the ocean where a distinct disturbance of the radioactive equilibrium is established in the U family towards a considerable ionium deficiency compared to U.--Auth.

3-3792. Kovalsky, V. V., and S. V. Letunova. THE IMPORTANCE OF MUD MICROFLORA IN THE MIGRATION OF COBALT AND THE ADAPTATION OF MICROORGANISMS TO THE MEDIUM IN BIOGEOCHEMICAL PROVINCES WITH DIFFERENT COBALT CONTENTS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 399-402, 3 tables, May-June 1959, pub. 1960, 3 refs.

Co and vitamin B_{12} were determined in the mud sediments of 96 stagnant basins in different biogeochemical provinces. It was found that microorganisms inhabiting muds poor in Co play twice as active a part in the migration of Co as the microorganisms of mud rich in this element. The percentage of Co combined with vitamin B_{12} is 11 times greater than in muds rich in Co. On an absolute basis, however, only a very small portion of total Co, from 0.0034 to 0.0386%, is combined as vitamin B_{12}.--F. Manheim.

3-3793. Dontsova, E. I. METHOD FOR DETERMINING OXYGEN-ISOTOPE RATIOS IN ROCKS AND MINERALS: Geokhimiya, in translation, 1959, no. 8, p. 824-838, 4 figs., 6 tables, pub. 1961, 9 refs.

In the article a method devised by the author is described for the reduction of rocks and minerals by graphite for the purpose of isotopic analysis of their oxygen. A description of the apparatus and of the procedure of carrying out the reaction is given. Experimental data of the reaction kinetics of the reduction of various rocks and on the completeness of the CO output are cited. The rock and mineral reduction by graphite is completed within 15-18 minutes in the temperature interval from 1,000° to 1,900°C. The CO output for various materials ranges from 95 to 100% depending on their chemical composition. Procedures are described to achieve a high purity of the gas. The analysis of the obtained carbon monoxide shows that N and hydrocarbon impurities, which interfere with the isotopic CO analysis in the mass-spectrometer, are practically absent. The sources of error are analyzed, and the reproducibility and the accuracy of the method is shown. The average error of the average value to be determined does not exceed 0.02% of relative values. The applicability of the method for various materials of investigation is shown, in particular for alumosilicate rocks containing alkalic and alkaline earth metals.--Auth.

3-3794. Friedman, Irving, and others. THE DEUTERIUM CONCENTRATION IN ARCTIC SEA ICE: Jour. Geophys. Research, v. 66, no. 6, p. 1861-1864, 3 figs., table, June 1961, 3 refs.

Samples taken from cores of sea ice collected near Ice Island T-3 at 80°18'N. 113°W., and on US-IGY Drifting Station Alpha at approximate locations of 85°40'N. 127°W., and 83°N. 165°W., were analyzed for their relative deuterium content. A plot of deuterium concentration vs. depth in the ice, from the T-3 ice core, shows 3 positions of minimum deuterium concentration.

These minima are interpreted as being due to the formation in the summer, and freezing in the early winter; of a surface layer of water of low deuterium concentration. This layer forms by the mixture of sea water with water from melted precipitation that is low in deuterium. The sea ice floats on this deuterium-poor layer, and this layer is the first material to be added to the ice floe when accretion by freezing begins in the early winter.

Several samples of surface water collected by the submarine U. S. S. Skate during the summer of 1958 at 86°44'N. 77°55'W., and 89°18.5'N. 45°00'W., prove the existence of such a deuterium-depleted layer at these locations.

Two cores taken on US-IGY Drift Station Alpha at approximate locations of 82°N. 165°W. and 85°N. 127° W. show no such clear deuterium variation. This is interpreted to indicate that no deuterium-depleted layer formed because 1) in the 2 or 3 years preceding ice collection on Drift Station Alpha precipitation was much less than at the other locations sampled, or 2) vertical mixing under Drift Station Alpha was greater than at the other locations.--Auth.

3-3795. Gerling, E. K., and Yu. A. Shukolyukov. ACCUMULATION OF A^{38} IN URANIUM MINERALS: Geokhimiya, in translation, 1959, no. 7, p. 750-764, 3 figs., 4 tables, pub. 1961, 26 refs.

The Ar^{38} content has been investigated in 17 U minerals ranging in age from $2\cdot10^8$ to $2\cdot10^9$ years. The content of U, Pb, rare earths, He, Xe, Cl has been determined in the samples. Corrections for the Ar^{38} loss have been made according to the data on the He and Xe losses. The calculated excessive quantity of Ar^{38} in minerals of the same age decreased with the increase of the Cl content which may be explained by the reaction $Cl^{35} (n_{\gamma}) Cl^{36} \xrightarrow{\beta} Ar^{36}$.

Corrections have been made for Ar^{38} according to the quantities of radiogenic Ar^{36}. The earlier proposed nuclear reactions cannot explain the experimental data. There is a proportionality between the U content and the Ar^{38} content. Between the quantities of Ar^{38} and Xe of neutron fission (Xe_n) a dependence of the type $Ar^{38}=aXe_n + b$ has been determined. Samples have been found which at a complete absence of Xe_n contain noticeable quantities of Ar^{38} ($Ar^{38}=b$). The possibility of Ar^{38} formation by the spontaneous fission of U^{238} and the neutron fission of U^{235} has been assumed. The Ar^{38} formation goes through the hypothetical radioactive isotope with $T_n=(690 \pm 230)\cdot10^6$ years. The yield of the latter by U fission must be 3%.--Auth.

3-3796. Benson, Bruce B., and Peter D. M. Parker. NITROGEN/ARGON AND NITROGEN ISOTOPE RATIOS IN AEROBIC SEA WATER: Deep-Sea Research, v. 7, no. 4, p. 237-253, 5 figs., table, March 1961, 14 refs.

Various factors which influence the concentrations of gases dissolved in sea water are discussed. A surface equilibrium model is proposed and results presented to test the model and to ascertain whether or not N dissolved in sea water is biologically and chemically inert. The method utilized Ar as a reference gas, with a mass spectrometer as the primary analytical tool. The conclusion is reached that within ± 1% the model is applicable and N is 'conservative.' The possible implications of apparent small differences between the predictions of the model and the experimental results are discussed. There is some evidence that the N 29/28 relative abundance in the dissolved gas may be greater than that in the atmosphere by approximately 1 part in 10,000.--Auth.

3-3797. Richards, Francis A., and Bruce B. Benson. NITROGEN/ARGON AND NITROGEN ISOTOPE RATIOS IN TWO ANAEROBIC ENVIRONMENTS, THE CARIACO TRENCH IN THE CARIBBEAN SEA AND DRAMSFJORD, NORWAY: Deep-Sea Research, v. 7, no. 4, p. 254-264, 3 figs., 2 tables, March 1961, 24 refs.

Mass spectrometric measurements of N/Ar and N isotope ratios have been used to examine the fate of N arising from the decomposition of organic matter in 2 anaerobic marine environments, the Cariaco Trench in the Caribbean Sea and the Dramsfjord in Norway.

Values of N_2/Ar in these waters are larger than would be expected from dissolved atmospheric gases. By assuming that the Ar concentration is biologically unaffected, the excess quantities of N_2 can be calculated. These are in good agreement with the amount of N which would be expected to arise from the decomposition of organic matter. The latter values are computed from the observed concentrations of N compounds and either the observed concentrations of inorganic phosphate or the amounts of O (either free or bound in the sulfate ion) consumed from the water.

It is shown that N isotope ratios are markedly different in the N of biogenic origin from those in N dissolved from the atmosphere.

It is shown that it is probable that free N can be formed from organic matter only through the denitrification of nitrate, formed as an intermediate.--Auth.

3-3798. McMullen, C.C., and others. ABSOLUTE RATIO OF B^{11}/B^{10} IN SEARLES LAKE BORAX: Geochim. et Cosmochim. Acta, v. 23, no. 1/2, p. 147-150, 4 tables, Apr. 1961, 7 refs.

B isotope ratios have been determined in Searles Lake [California] minerals to shed light on the controversial problem of isotopic fractionation in naturally occurring B. Solid-source mass spectrometric measurements on B in the form of borax found higher B^{11}/B^{10} ratios in tincal than in borax from the same deposits.--F. Manheim.

3-3799. Vinogradov, A. P., and others. ISOTOPIC COMPOSITION OF LEADS FROM THE ORES OF THE BALTIC SHIELD: Geokhimiya, in translation, 1959, no. 7, p. 689-749, 8 figs., 10 tables, pub. 1961, 29 refs.

The isotopic composition of the galena Pb and of the Pb impurities from various ores of different genetic types and of different age from the whole territory of the Baltic shield has been determined. All together about 100 samples have been investigated. According to the isotopic Pb composition 2 evolutional branches of leads stand out: the svekofennian and the karelian type. The svekofennian leads are more monotonous and are characteristic of higher values of all 3 isotopes with regard Pb^{204} than the karelian leads. Besides leads corresponding to the age of their formation, a series of considerably more ancient leads than the ores and rocks including them has been found. A graph is proposed for calculating the age of leads according to their isotopic composition based on ideas about the differentiation of terrestrial matter and empirical regularities of variations in the isotopic composition of synchronous leads. Some age groups of leads typical of the whole territory are singled out. Assumptions are made regarding the geological history of the shield on the basis of data on the isotopic compositions of leads.--Auth.

3-3800. Vinogradov, A. P., and others. DETERMINATION OF ABSOLUTE AGE BY THE CARBON^{14} METHOD (PART II): Geokhimiya, in translation, 1959, no. 8, p. 815-823, 3 figs., table, pub. 1961, 8 refs.

In the article are given results of determination of the absolute geological age according to C^{14} of samples supposedly of the period of the Waldai glaciation of eastern Europe and of the Zyryansk glaciation of eastern Siberia, being of a synchronous age. Coal samples from archeological excavations of the Khoresm expedition and samples of a scorched tree connected with the volcanic action on the Kamchatka peninsula have also been dated. The determinations of C^{14} were carried out simultaneously on 2 settings by means of counting the activity of the 2 gases, ethane and carbonic acid. The counting settings were improved in comparison to the settings previously described, as a result of which the background was lowered considerably.--Auth.

3-3801. Rosenfeld, John L., and Armond B. Chase. PRESSURE AND TEMPERATURE OF CRYSTALLIZATION FROM ELASTIC EFFECTS AROUND SOLID INCLUSIONS IN MINERALS?: Am. Jour. Sci., v. 259, no. 7, p. 519-541, 9 figs., table, Summer 1961, 20 refs.

Earth processes commonly result in the transfer of a mineral grain from the pressure-temperature (P, T) condition of its origin to considerably different pressure-temperature conditions. If a mineral grain (h) includes a grain of another mineral (i), transfer to new P-T conditions commonly will cause anisotropic elastic strain effects around the inclusion owing to different coefficients of thermal expansion (α) and compressibility (β) for the 2 minerals. To the extent that these elastic effects remain reversible over geologic time intervals, they represent stored information concerning the pressure and temperature of origin. The differential equation for the pressure-temperature curve representing absence of anisotropic stress around an inclusion of one isometric crystal (also a homogeneous fluid) inside of another isometric crystal is:

$$\left.\frac{dT}{dP}\right|_{P_i = P_h;\, T_i = T_h} = \frac{\beta_h - \beta_i}{\alpha_h - \alpha_i}$$

Experimental determination of 2 such P-T curves (conditions: $P_i=P_h$; $T_i = T_h$) for a given host containing 2 different kinds of inclusions, known to have been included contemporaneously, would result in an intersection representing the pressure and temperature of origin (P_o, T_o).

Among suggested techniques for determination of P-T curves is one using a window pressure-temperature bomb for observation of specimens between crossed polarizing filters to obtain the pressure-temperature coordinates for points of null piezobirefringence around inclusions. An auxiliary method, based on conventional P-T equipment, involves an electrical null technique using either a symmetrical combination of 2 "slide-wire" piezometers (Bridgman) or a related device and a Wheatstone bridge. The 2 "slide-wires" comprise 2 resistances of the bridge in the first device. In the second device the bridge is unbalanced by severance of one of its arms.

The few noted natural examples of stress effects around inclusions in diamond and associated pyrope are consistent with extrapolations based on known values of α and β and inferred pressure-temperature conditions within the earth. Examination of these minerals, having a probable origin in the mantle but now included in the kimberlites, should allow determination of specific temperatures at specific pressures equivalent to depths within the mantle of the order of 100 mi. or more, using available experimental equipment.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Stratigraphy 3-3650; Geochemistry 3-3777; Sedimentary Petrology 3-3844.

3-3802. Sinkankas, John. GEMSTONES AND MINERALS, HOW AND WHERE TO FIND THEM: 387 p., 133 figs., Princeton, New Jersey, D. Van Nostrand, 1961, refs.

Handbooks for mineral and gemstone collectors largely ignore or touch only lightly upon the well-established relationships between rocks and the mineral deposits likely to be found in them. This book attempts to fill the needs of the nonprofessional student of the earth sciences by presenting selected simplified geological information designed to make field work intelligently purposeful. Chapters are furnished on: planning field trips; tools and how to use them, including explosives; rocks and how to recognize them; the formation, structure, and outcropping of mineral deposits; prospecting and collecting practices; preparation and cleaning of mineral specimens; storage and exhibit of specimens, and the marketing of collected materials. Five appendices include tabular listings of over 250 mineral species and the effects of water and acids upon them, a listing of minerals which are sensitive to various environmental influences, useful addresses of offices and agencies, an extensive list of libraries which provide local geological reference material, and a bibliography divided into sections on prospecting and collecting, claim information, sources of geological information and publications, textbooks, locality information, and magazines and journals.--Auth.

3-3803. Kitaigorodsky, A.I. THE THEORY OF CRYSTAL STRUCTURE ANALYSIS. Translated from the Russian by David and Katherine Harker: 275 p., 23 figs., 18 tables, New York, Consultants Bureau, 1961, 65 refs.

A translation of Teoriya Strukturnogo Analiza, originally published by the U. S. S. R. Academy of Sciences Press in Moscow in 1957. This monograph, generalizing the author's works of 1953-1955, is directed toward the construction of a complete theory of the relationships between structure amplitudes. The author has attempted to touch on all questions in the theory of structure analysis being developed in the Soviet Union and abroad.--From foreword.

The following major topics are covered: mathematical introduction, principles of the theory, structure amplitudes and products as random quantities, theory of the relations between structure amplitudes, analysis of the convolution of the electron density, methods of obtaining agreement between the measured and calculated structure amplitudes.

3-3804. Leonova, V.A. THE INFLUENCE OF ADMIXTURES ON THE PARAMETER OF THE CELL OF URANINITE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 415-417, fig., 3 tables, May-June 1959, pub. 1960, 12 refs.

The influence of Th, radiogenic Pb, and rare earths on the cell constants of uraninite were investigated. It was found that the unit cell dimensions increase with increasing concentration of Pb and Th, but decrease with admixture of rare earths of the Y group. Chemical analyses of 14 uraninites are given.--F. Manheim.

3-3805. Mamedov, Kh. S., and others. ON THE WÖHLERITE-LAVENITE AND RINKITE-MOSANDRITE GROUPS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 578-580, 4 figs., table, May-June 1959, pub. 1960, 8 refs.

A discussion of the structure and interrelations of the wöhlerite-lavenite and rinkite-mosandrite groups is presented. Recent investigations of seidozerite and cuspidine have shed light on the function of the "tilleyite band" in these mineral groups. As a result, it is concluded that the minerals of the cuspidine-wöhlerite-lavenite group are only polymorphic modifications of the seidozerite-rinkite group. The term "polytypical modification" is suggested as descriptive of the relationships.--F. Manheim.

3-3806. Mamedov, Kh. S., and others. THE CRYSTALLINE STRUCTURE OF TRICALCIUM SILICATE HYDRATE. TSH=$6CaO \cdot 2SiO_2 \cdot 3H_2O = Ca_6[Si_2O_7](OH)_6 = Ca_4[Si_2O_7](OH)_2 \cdot 2Ca(OH)_2$: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 574-576, 3 figs., table, May-June 1959, pub. 1960, 6 refs.

The mineralogy and crystallography of tricalcium silicate hydrate (TSH) has been investigated. The thermal and hydration behavior of TSH as reported previously in the literature is in full agreement with a structure incorporating the "tilleyite band" (cuspidine "molecule") as an essential feature.--F. Manheim.

3-3807. Korolev, Yu. M. THE STRUCTURE OF ALLEVARDITE: Kristallografiya, in translation, v. 5, no. 6, p. 848-852, 3 figs., 5 tables, 1960, pub. 1961, 10 refs.

The unit cell of allevardite, $Na_{0.17}Ca_{0.21}K_{0.03}(H_3O)_{1.00}(Al_4)[Al_{1.45}Si_{6.55}O_{20}](OH)_4 \cdot 3.24H_2O$ consists of 2 open layers resembling those in mica; the name allevardite layer is proposed. A one-dimensional Fourier synthesis has been used to determine the Z coordinates of the layers; it is found that $(H_3O)^+$ ions are responsible for binding the layers together. The small repeat of Z is caused by variations in the amounts of the cations that bind the layers together (K, Ca, hydroxonium).--Auth.

3-3808. Bakakin, V.V., and N.V. Belov. CRYSTAL STRUCTURE OF PARACELSIAN: Kristallografiya, in translation, v. 5, no. 6, p. 826-829, 3 figs., table, 1960, pub. 1961, 11 refs.

Structural resemblances among paracelsian, danburite, and hurlbutite are discussed. X-ray analysis of paracelsian indicates that structural coordinates, determined earlier by Smith, must be revised. The corrected coordinates require distances as follows: Si-O and O-O in SiO_4 tetrahedra, 1.65 and 2.80 Å respectively; Al-O and O-O in AlO_4 tetrahedra 1.72

and 2.82Å; Ba-O ranges from 2.73 to 2.83Å.--E. G. Ehlers.

3-3809. Komkov, A. I. MINERALS IN THE EUXENITE-POLYCRASE AND PRIORITE-BLOMSTRANDINE SERIES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 584-586, table, May-June 1959, pub. 1960, 11 refs.

A study of the problem of classifying the titanoniobates of Y and the rare earths is reported. The structural relationships of the above minerals are complicated by the fact that they are found in nature chiefly in a metamict state, and structural studies can only be made after heating. The results of the present work indicate that if minerals in the euxenite-polycrase and priorite-blomstrandine series have not been completely decomposed by metamict processes into oxides they regain their pre-metamict structures on heating and may be unequivocally determined by X-ray methods. If metamict processes have destroyed the lattice completely, it is impossible to distinguish these series by X-ray data, with the exception of eschynite.--F. Manheim.

3-3810. Komkov, A. I. X-RAY STUDIES OF RARE-EARTH COMBINATIONS OF THE TYPE $TRNbO_4$: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 589-590, 2 tables, May-June 1959, pub. 1960, 9 refs.

X-ray studies were carried out to discover whether the rare-earth elements form a single continuous isostructural niobate series, or whether substitutions lead to changes in the crystal structure, as in tungstates and molybdates. In addition, it was desired to learn the relationships with the fergusonite (tantaloniobate) group. The investigation showed that the niobates of the type $RNbO_4$ are isostructural monoclinic modifications of $(R, Y)NbO_4$, obtained by heating and subsequent quenching of natural fergusonite. Studies with high-temperature ionization apparatus showed that combinations of the $TRNbO_4$ type change from a monoclinic to a tetragonal cell on heating.--F. Manheim.

3-3811. Soboleva, M. V., and I. A. Pudovkina. MINERALS OF URANIUM: REFERENCE BOOK: U. S. Atomic Energy Comm., [Pub.] AEC-tr-4487, 455 p., 206 figs., 240 tables, 1961, 439 refs.

A translation of Mineraly Urana Spravochnik, Gosudarstvennoe Nauchno-Tekhnicheskoe Izdatelstvo Literatury po Geologii i Okhrane Nedr, Moscow, 1957. The large amount of practical material accumulated in the study of U minerals and published in numerous periodicals, and the methods of studying U minerals and the material composition of ores are not, at present, easily available in any one handbook. This book collects and classifies material already known and the results of observations and studies which have not been published.

The volume is in 2 parts. The first part deals with methods of examining minerals and studying their properties. In the second part, 91 U minerals and 60 U-bearing minerals are described. The following information is given for each mineral: physical properties, optical properties, chemical composition, conditions of occurrence, references. Tables of optical constants and specific gravities are given in appendices.--A. C. Sangree.

3-3812. Boyle, R. W. NATIVE ZINC AT KENO HILL: Can. Mineralogist, v. 6, pt. 5, p. 692-694, 1961, 11 refs.

Small metallic plates and scales of native Zn occur in the oxidized lodes at the Elsa mine, Keno Hill, Yukon. It is associated with native Ag, limonite, manganese oxides, cerussite, anglesite, S, and oxidized sphalerite, freibergite, and galena. X-ray fluorescence and spectrographic analysis show it to contain up to 10% Sn, Pb, and Cd, and traces of Fe, Mn, B, Si, Cu, Ag, Ca, and Ba. The Zn comes from sphalerite by organic compound reduction or auto-oxidation in a neutral to alkaline environment.--D. D. Emerson.

3-3813. Westland, A.D., and F. E. Beamish. NATIVE PALLADIUM FROM COLOMBIA: Can. Mineralogist, v. 6, pt. 5, p. 689-691, fig., 2 tables, 1961, 8 refs.

An 8 mg. grain of native Pd from Colombia was analyzed, first by a quartz spectrograph and then by wet techniques. It contained 86.2% Pd, 8.1% Pb, 3.0% Rh, 1.6% Pt, 0.X% Os, Ir, Ru, and Sn, and trace amounts of Au, Ag, Fe, Cu, and Ni. Despite the significant amount of Pb, X-ray diffraction showed a = 3.91 Å, very close to the a = 3.88 Å of pure Pd.--D. O. Emerson.

3-3814. Ontoev, D. O. LILLIANITE FROM THE BUKUKA DEPOSIT AND THE CONDITIONS UNDER WHICH IT FORMED: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 591-593, 3 figs., 2 tables, May-June 1959, pub. 1960, 14 refs.

Lillianite, $Pb_3Bi_2S_6$, is described from the Bukuka wolframite deposits, U. S. S. R. The mineral occurs in massive granular aggregates filling drusy cavities in close association with acicular cosalite, late pyrite, and other minerals. Chemical, X-ray, optical, and spectrographic analyses of the mineral are reported. The general occurrence and paragenesis of the occurrence indicates that the lead sulfobismutites formed during the final stage of mineralization, after crystallization of molybdenite, wolframite, bismuthinite, quartz, sphalerite, and other minerals. The residual solutions preserved in drusy cavities in the vein quartz were considerably enriched in Bi, Pb, S, and other volatile elements. Within the cavities the following sequence is established with falling temperature: lillianite-solid solution of cosalite and galena-cosalite-galena.--F. Manheim.

3-3815. Frondel, Clifford. MAGNUSSONITE FROM STERLING HILL, NEW JERSEY: Arkiv för Mineralogi och Geologi, bd. 2, h. 6, no. 45, p. 571, 1961, ref.

Comparison of an undescribed manganese arsenite from Sterling Hill, New Jersey, with material described as the new mineral magnussonite from the Långban district, Sweden, has proved the complete identity of the 2 minerals.--M. S.

3-3816. Firsov, L. V. A FIND OF SEYRIGITE IN THE NORTHEAST OF THE USSR: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 577, May-June 1959, pub. 1960, ref.

A first occurrence of seyrigite in the U. S. S. R. is reported. The mineral is found in zones of mineralization associated with Upper Cretaceous pegmatoid and aplitic dikes in the Usinsk ore deposit (Magadan batholith). The mineral is associated with scheelite, molybdenite, quartz, microline, and biotite. Refractive indexes are 1.94-1.990. In addition to the main elements, Ca, W, and Mo, traces of Fe and Bi were found chemically. Chemical analysis is as follows: CaO 21.25%, WO_2 63.00%, MoO_3 13.48%, FeO tr, and H_2O 0.24%. Total 97.97%. This corresponds to a mineral formula of $Ca_{1.027}(W_{0.736}Mo_{0.254})O_4$.--F. Manheim.

3-3817. Servos, Kurt. **SYNOPTIC CHART OF COMMON ROCK-FORMING SILICATES – PART I:** Am. Geol. Inst., AGI Data Sheet 26, 2 p. in GeoTimes, v. 6, no. 1, p. 35-36, July-Aug. 1961, 3 refs.; also pub. separately.

Four groups are treated in this chart: sorosilicates, cyclosilicates, unclassified silicates, and nesosilicates. The following information is given in tabular form: name, formula, crystal system, class; common forms, cleavage twin., hardness, sp. gr.; color, streak, luster; habit; tests or diagnostic features; similar species, isotypes, isomorphism; paragenesis, occurrence, association, alteration.--L. M. Dane.

3-3818. Sinkankas, John. **WHAT DO WE REALLY KNOW ABOUT THE FORMATION OF AGATE AND CHALCEDONY?**: Lapidary Jour., v. 15, no. 2, p. 242-252, 296, June 1961, 16 refs.

Older investigations into the chalcedony problem are reviewed and compared to recent work on the synthesis of chalcedony and its probable genesis in natural environments. Although at least one recent work supports Liesegang's colloidal theory of the formation of the banding and formation of dendritic inclusions in chalcedony, objections to this theory are advanced and supported by the evidence obtained from examination of numerous sections of chalcedony. Inclusions are divided broadly into 4 types; each is discussed and probable modes of formation are advanced. Coloration in chalcedony is briefly discussed and recent work cited in the case of iris chalcedony. It is concluded that much work remains to be done in the chalcedony problem before satisfactory explanations for the genesis and internal structure of chalcedony masses are obtained.--Auth.

3-3819. Fang, Tê-Liang. **PYROSMALITE IN THE WAFANSI DEPOSIT (CHINA)**: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 594-597, 4 illus., table, May-June 1959, pub. 1960, 4 refs.

The rare Fe-Mn mineral, pyrosmalite, $(Mn, Fe)_8Si_6O_{15}(OH, Cl)_{10}$, has been found in the Wafansi deposit of China. X-ray and mineralogical data of the present occurrence are reported. The mineral is found as one of the main minerals of ferromanganese silicate ores in close association with sedimentary rhodochrositic ores, chlorite, and graphite. Pyrosmalite sometimes replaces rhodochrosite oolites so completely that their concentric structure is lost, but is ordinarily found in radiating networks. It is assumed that pyrosmalite formed later than the sedimentary carbonate ores, and its formation was evidently due to the introduction of Cl by hydrothermal solutions.--F. Manheim.

3-3820. Ehlers, Ernest G., and Karl V. Hoover. **THE CLAY MINERALOGY OF THE SHALY PORTIONS OF THE BRASSFIELD LIMESTONE**: Ohio Jour. Sci., v. 61, no. 4, p. 227-234, 4 figs., July 1961.

The Brassfield limestone of Silurian age is exposed in southwestern Ohio, where it can be divided lithologically into a northern and a southern zone. The southern zone is distinguished from the northern one primarily by a greater percentage of shale and a larger number of chert nodules.

Clay samples from the shaly intervals of drill cores and outcrops of the Brassfield were collected for study. They were treated with dilute glacial acetic acid to remove the carbonate minerals, and portions of each acid-treated sample were mounted on glass slides for study of the X-ray diffraction patterns. They were X-rayed both before and after treatment with ethylene glycol and heat, and the diffraction patterns were studied to determine the relative amounts of kaolinite and illite present, based on the intensities of (001) reflections. Newberry analyses which were run on most of the samples indicate that the Brassfield limestone of the southern zone has a higher percentage of insoluble material (mainly clay size) than that of the northern zone.

Illite was the predominant clay mineral in all samples, with kaolinite, mixed-layer illite-chlorite, and chlorite being present, but in lesser amounts. Kaolinite was relatively more abundant in the southern zone than in the northern one, which may indicate that the southern area was closer to the sources of noncarbonate sediments.--K. V. Hoover.

3-3821. Bobrievich, A. P., and others. **A XENOLITH OF DIAMOND-BEARING ECLOGITE**: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 581-583, 3 illus., 2 tables, May-June 1959, pub. 1960, 7 refs.

Mineralogic and petrographic studies of a diamond-bearing eclogite xenolith from the "Mir" kimberlite pipe are reported. The eclogite is a coarse-grained aggregate of red-orange garnet and dark green monoclinic pyroxene, in which are embedded octahedra of diamonds, together with idiomorphic crystals of graphite. Chemical analyses of the rocks are given. It is tentatively concluded that the diamond-bearing eclogite was plucked from the crystalline basement by the kimberlite magma. A genetic relationship of the diamonds with the kimberlite magma is proved by presence of idiomorphic crystals of olivine as inclusions in the diamonds.--F. Manheim.

3-3822. Murdoch, Joseph, and Robert W. Webb. **SUPPLEMENT TO MINERALS OF CALIFORNIA, FOR 1955 THROUGH 1957.** With index to Minerals of California, arranged by counties, prepared by Elizabeth Collins: California, Div. Mines, Bull. 173 Supp., 64 p., 1960, refs.

The last summary of occurrences of minerals was published in Bulletin 173, Minerals of California [Geoscience Abstracts 1-1756], and included all reported occurrences through Dec. 31, 1954. This paper constitutes additions as reported in the literature and by personal communication from Jan. 1, 1955 through Dec. 31, 1957.

In the 3-year period, 3 new minerals have been described from California: galeite (1955), gerstleyite (1956) and nekoite (1956). In addition, 23 new species have been reported for the first time. Hillebrandite has also been re-established as a valid species from the state. Crestmore, Riverside County, continues to supply new minerals and additional species. The glaucophane schists, prominent in Coast Ranges geology, yield new and interesting occurrences.

U and rare-earth minerals have multiplied in their reported frequency as might have been predicted. It is noteworthy that autunite, for example, was reported from 5 localities in 3 counties in Bull. 173; it is now known from 25 localities in 10 counties. Carnotite was unreported in Bull. 173; it is now entered from 14 localities in 9 counties. In addition, at least 15 of the 27 minerals new to California are radioactive or rare-earth minerals.--From pref.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Geomorphology 3-3618; Geochemistry 3-3780, 3-3782, 3-3801; Mineralogy 3-3817, 3-3821; Mineral Deposits 3-3868, 3-3879.

3-3823. Ustiev, E.K. THE ANYUY VOLCANO AND PROBLEMS OF QUATERNARY VOLCANIC ACTIVITY IN NORTHEASTERN U.S.S.R.: Problems of the North - Problemy Severa, in translation, no. 1, p. 91-102, 3 figs., 1958, pub. 1960, 28 refs.

A volcanic cone and late Quaternary lava flows in the Monni valley, S. Anyuy range, were investigated in 1953. Recent volcanic activity in an area 1,000 mi. removed from the Pacific Ocean volcanic belt is rarely encountered and represents an independent geotectonic system. Lavas of the valley are typical representatives of the alkaline E. Asiatic province. Their extremely low viscosity distinguishes them from the alkaline-lime lavas erupted by present volcanoes of the Pacific Ocean active zone.

The Monni valley is a longitudinal anticlinal valley, possibly to some extent of fault origin. Its structure and morphology are described. The volcano is located almost over a place where several tectonic fractures intersect and is situated within a granitoid intrusion, not far from the northern boundary of the intrusion and Mesozoic rocks. It is a roughly truncated cone, 120 m. high on the E. and 90 m. on the W. Its physical appearance and history are described, also the basaltic extrusions associated with a series of fractures in the bottom of the valley.

Quaternary lavas have also been definitely identified in the Moma river valley and in northern Taygonos peninsula. Other possible manifestations of Quaternary volcanic activity are noted. All of them are associated with boundaries of some of the most important tectonic regions of NE. Asia and with recent tectonic movements in zones which had been in existence for a long time. Conditions underlying the outbreak of the late Quaternary volcanic activity in the Monni valley are linked with a slow structural development in the NE. Kolyma region which ended in postglacial time with extensive differential displacements of block masses, the renewal of tectonic fractures, and extrusions of magma.--A.C. Sangree.

3-3824. Pinus, G.V. SOME SYSTEMATIC RELATIONSHIPS IN THE LOWER CAMBRIAN VULCANISM OF TUVA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 500-501, May-June 1959, pub. 1960.

The volcanic rocks in the Lower Cambrian sedimentary-volcanic sequence in the Tuva district represent the earliest manifestation of magmatic activity in the Caledonian geosyncline. The volcanic rocks are chiefly flows, more rarely effusives and their accompanying pyroclastic rocks. In addition, hypabyssal bodies such as diabase sills and labradorite porphyries are common. The present data indicate that the volcanic activity coincided with periods of upward movement that occurred against a general background of geosynclinal subsidence. There appears to be shifting of activity to the inner parts of the geosyncline with passage of time.--F. Manheim.

3-3825. Sokolova, N.T., and V.V. Korolev. WALL ROCK ALTERATION OF QUARTZ-PORPHYRY RELATED TO RARE-METAL MINERALIZATION: Geokhimiya, in translation, 1959, no. 8, p. 865-873, 3 figs., 2 tables, pub. 1961, 2 refs.

The wall rock alteration of quartz porphyries accompanying rare metal ore formation is characterized by the addition of a great amount of alkali into the rock, both as K and as Na. This alteration is directly related to the process of ore deposition and apparently synchronous with it. The scale of hydrothermal rock alteration increases strongly with depth.--Auth.

3-3826. Sobolev, N.D. CONTRIBUTION TO THE PETROCHEMISTRY OF ULTRABASIC ROCKS: Geokhimiya, in translation, 1959, no. 8, p. 839-864, 19 figs., 6 tables, pub. 1961, 21 refs.

In the article are given chemical analyses of ultrabasic rocks and stony meteorites of the U.S.S.R. (300 analyses) recalculated for the modal mineral composition. The genetic groups of ultrabasic rocks: 1) hypermagbasites - derivatives of the peridotitic layer of the earth (sima); 2) ultraferbasites - differentitates of the gabbroic magma (sialma); and 3) ultraalbasites - differentiates of the magma of alkaline gabbroids (sialma), as well as stony meteorites have their definite numerical characteristics. It has been established that: 1)dunites of ultraferbasites and ultraalbasites have z=100-95 and hypermagbasites z=95-80, and, accordingly, peridotites z=80-50 and z=95-80; out of pyroxenites diallagites-koswites are typical of ultraferbasites, websterites are typical of ultraalbasites, and bronzitites of hypermagbasites; 2) the formation of serpentinites at the expense of a definite variety of ultrabasic rocks and their belonging to one of the 3 genetic groups may be established according to the chemical composition; 3) in the process of serpentinization of the ultrabasic rocks an incarrying of SiO_2 up to 2-3% takes place; 4) in the terrestrial ultrabasic rocks there are practically no varieties with ratios of olivine 50-15% and of pyroxenes 50-85; most of the stony meteorites have such a composition.--Auth.

3-3827. Gapeeva, G.M. USSURITE - A SPECIAL VARIETY OF ALKALI BASALT ROCKS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 610-611, fig., table, May-June 1959, pub. 1960, 6 refs.

Ussurite is closest to the trachydolerites, but shows distinctive structural and mineralogical features. The rock is not composed of uniform-grained masses of crystals of plagioclase and pyroxene, but of relatively large (ca. 0.5 mm.) xenomorphic grains of potassic oligoclase containing idiomorphic microliths of titaniferous augite and ore minerals as poikilitic inclusions. The rock contains analcime which appears sporadically replacing individual crystals of oligoclase. Fine, hairlike crystals of apatite may form a matted aggregate literally filling the analcime grains. The mass also contains xenocrysts of broken and often corroded olivine. Chemical analyses are provided.--F. Manheim.

3-3828. Shinkarev, N. F., and L. L. Perchuk. A DISCOVERY OF ALKALIC GABBROIDAL ROCKS IN THE ALAI-TURKESTAN ALKALIC PROVINCE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 614-615, table, May-June, pub. 1960.

The Zardalek intrusive mass occurs in Silurian carbonate rocks and has a multiphase, complex structure. Phase 1 consists of eucrites and monzonites, accompanied by theralitic gabbro, teschenite, and analcime monzonite. Phase 2 consists of melanocratic syenites accompanied by essexites and bostonite and syenite porphyry dikes. Phase 3 is composed of nepheline and sodalite syenites, and no dikes of the alkalic gabbroidal series were found within the intrusion or in the contact aureole. This probably indicates that these rocks were formed by assimilation of carbonate material by the magma and differentiation in place.--F. Manheim.

3-3829. Winkler, Helmut G. F., and Hilmar von Platen. EXPERIMENTELLE GESTEINSMETAMORPHOSE - IV. BILDUNG ANATEKTISCHER SCHMELZEN AUS METAMORPHISIERTEN GRAUWACKEN [Experimental Rock Metamorphism — IV. Formation of Anatectic Melts from Metamorphosed Graywackes]: Geochim. et Cosmochim. Acta, v. 24, no. 1/2, p. 48-69, 5 figs., 6 tables, June 1961, 14 refs.; text in German, abs. in English.

Experimental high-grade metamorphism and anatexis of different graywackes has been studied under 2,000 atm. H_2O-pressure. The high-grade metamorphic mineral assemblage is that of biotite-cordierite-plagioclase-alkali feldspar-quartz-gneisses, with in some cases sillimanite. Quantitatively, the mineral content differs due to the different chemical compositions of the metamorphosed graywackes. If the positions of the points in the ACF-diagram are corrected for the amount of biotite formed, then they give the right ratios of the quantities of the other observed minerals.

For most of the investigated rocks an anatectic melt begins to form at 685°C.; for others this temperature is higher, up to 725°C. As with metamorphosed clays, the first melt to be formed is an aplitic alkali feldspar-quartz melt. But with small rise in temperature, plagioclase is fractionally dissolved in the melt, together with a certain amount of biotite, cordierite, and sillimanite. The composition of the melt changes quickly with rise in temperature from aplitic over granitic to granodioritic and in most cases to tonalitic. A tonalitic or sometimes a granodioritic composition is a final stage in the anatectic process of previous graywackes, because further rise in temperature scarcely changes the composition of the melts. The cotectic formation of tonalitic anatectic melts have been observed which have dissolved more quartz than would be supposed.

The amount of melt increases quickly with rising temperature, but at about 780°C. a maximum is reached. In most cases over 70 up to 96% of the metamorphosed graywackes have been liquified; if the metamorphite contained especially high quantities of quartz and/or an An-rich plagioclase then the amount of melt is smaller, but nevertheless it still composes two-thirds of the anatectic rock complex. If separated from the crystalline remainder it can intrude and form tonalites or granodiorites, respectively. If not separated far from the place of formation it may represent the "granitoid" portion of migmatites. Results are given for the solidus-liquidus relations of plagioclases in complex anatectic systems; these are compared with those in the system Ab-An-H_2O.--Auth.

3-3830. Albers, John P. SODA METASOMATISM IN THE EAST-SHASTA COPPER-ZINC DISTRICT, NORTHERN CALIFORNIA: Geol. Soc. India, Jour., v. 1, p. 31-43, 3 figs., table, 1959, 13 refs.

In this paper albitic volcanic, intrusive, and tuffaceous sedimentary rocks ranging from mafic to felsic in composition and from Middle Devonian to Late Jurassic in age are described. Most of the rocks contain albite as the only feldspar and fall into the petrographic classification of keratophyre and quartz keratophyre. Spilite, meta-andesite, metadacite, metabasalt, albite diabase, metaquartz diorite, and albite granite are other petrographic types. Virtually all the rocks retain their primary structures and textures although they contain abundant chlorite, fine-grained white mica, actinolite, and other minerals of secondary origin. Fresh augite coexists with albite in a few specimens.

Albite of demonstrably secondary origin occurs as partial replacement of plagioclase, and as veinlets, amygdule fillings, and overgrowths. It is concluded from the abundance and widespread distribution of demonstrably secondary albite that virtually all the albite in the rocks of the area is secondary, formed principally if not entirely by soda metasomatism during a Late Jurassic orogeny.

The albitizing agents are believed to have been hot aqueous fluids derived from one or any combination of 3 possible sources: 1) resurgent sea water, 2) a subjacent pluton of trondhjemite, and/or 3) hydrous minerals undergoing metamorphism to less hydrous types.--Auth.

3-3831. Park, R. G. THE PSEUDOTACHYLITE OF THE GAIRLOCH DISTRICT, ROSS-SHIRE, SCOTLAND: Am. Jour. Sci., v. 259, no. 7, p. 542-550, 3 figs., pl., table, Summer 1961, 9 refs.

During the closing stages of the Laxfordian orogeny, the Lewisian basement complex of Gairloch [NW. Highlands of Scotland] suffered widespread crushing and shearing, which affected each of 4 different rock groups in a distinctive manner. A variety of crush veins were produced which vary in habit according to the environment of formation.

Many of the veins intrude the wall rock and bear convincing evidence of the movement of the vein material from its source in a crush plane to the relatively undisturbed host rock. Some of the veins carry structures, such as relic glass and spherulites, which indicate that part of the vein material was melted at the time of intrusion.

It is concluded that, although recrystallization and devitrification have largely obscured the evidence, true pseudotachylite exists together with ultramylonite in the Gairloch crush rocks.--Auth.

3-3832. Logvinenko, N. V. THE NATURE OF ALTERATION IN CARBONIFEROUS ROCKS IN THE SOUTHEASTERN PART OF THE GREATER DONETS BASIN: Akad. Nauk SSSR, Doklady, Earth Sci Secs., in translation, v. 126, no. 1-6, p. 612-613, 3 figs., May-June 1959, pub. 1960, 4 refs.

Rock samples from the Ipatovo exploratory drill hole were examined by optical and differential thermal methods. The samples were taken at depths ranging from 2,077 to 2,323 m. in Carboniferous metamorphosed argillaceous rocks and volcanics. Within the greater Donets basin all transitions are observed from unaltered or slightly altered rocks to the zone of metamorphism and late metagenesis. The present drill hole represents the last-named zone in the southeastern part of the Donets basin, corresponding to the lean and anthracitic coals.--F. Manheim.

3-3833. Clabaugh, S. E., and Robert E. Boyer. ORIGIN AND STRUCTURE OF THE RED MOUNTAIN GNEISS, LLANO COUNTY, TEXAS: Texas Jour. Sci., v. 13, no. 1, p. 7-16, 3 figs., March 1961, 7 refs.

The Red Mountain gneiss occurs as several concordant layers of a slightly foliated to strongly deformed granite in the upper part of a thick sequence of Precambrian metasedimentary rocks (Packsaddle schist). Magmatic origin of the Red Mountain gneiss is evidenced by xenoliths of schist in granite gneiss, relic porphyritic texture of thin sills of granite gneiss, and a few locally discordant contacts of gneiss with schist. Along part of its length the largest sill lies between schist and gneissic quartz diorite (Big Branch gneiss). Near the granite gneiss the quartz diorite was coarsened and enriched in K feldspar to produce gneissic quartz monzonite. Lineation in all of the rocks is approximately parallel to the axes of major folds, and foliation parallels bedding and sill contacts. Quartz axis orientation diagrams generally show incomplete girdles with multiple maxima at angles of 40° to 75° from the lineation in both deformed granite and metasedimentary rocks. Major regional deformation probably occurred in a single period which began before intrusion of the Big Branch quartz diorite and ended after intrusion of the Red Mountain granite. Subsequent faulting with horizontal displacement occurred in Precambrian time, and normal faulting took place in late Paleozoic time.--Auth.

3-3834. Kruglov, S. S. TABULAR INTRUSIONS IN THE DZHENTU RANGE OF THE NORTHWESTERN CAUCASUS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 492-494, May-June 1959, pub. 1960, 13 refs.

The Dzhentu intrusions cut lower Paleozoic rocks and are themselves regarded as having a lower age limit of early Carboniferous. The upper age limit is determined by the discovery of cobbles of the rocks in Lower Permian sediments. These data indicate that the intrusions, as well as synchronous rocks of other areas such as the Pshekish and Urup belong to the final phase of the middle Paleozoic or to the initial phase of the late Paleozoic Caucasian magmatic cycle.--F. Manheim.

10. SEDIMENTARY PETROLOGY

See also: Stratigraphy 3-3650; Engineering Geology 3-3920, 3-3921, 3-3922.

3-3835. Dubar, G. P. THE DISCOVERY OF CHAMOSITE ROCKS WITH OOLITIC STRUCTURE IN THE LENA BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 468-469, 2 figs., May-June 1959, pub. 1960, 2 refs.

Chamositic rocks were found in marine Liassic and Aalenian (Jurassic) strata of the Lena basin. The chamositic rocks are green with chalky brown spots, dense, unstratified, and with inclusions of large, carbonized plant remains and large, angular sand-clay pebbles. These beds may serve as marker beds for the marine Jurassic strata. The environment of origin was probably in a mobile, shallow-water marine environment. Partial chemical analyses are given. --F. Manheim.

3-3836. Beerbower, James R. ORIGIN OF CYCLOTHEMS OF THE DUNKARD GROUP (UPPER PENNSYLVANIAN-LOWER PERMIAN) IN PENNSYLVANIA, WEST VIRGINIA, AND OHIO: Geol. Soc. America, Bull., v. 72, no. 7, p. 1029-1050, fig., 3 tables, July 1961, 53 refs.

Cyclothems in the Dunkard group (uppermost Pennsylvanian and/or lower Permian) in Pennsylvania, West Virginia, and Ohio comprise an alternating sequence of alluvial-plain and lacustrine delta-plain sediments and show an asymmetric sequence of depositional environments imposed on symmetrical cycles of clastic grain size and of submergence. The widespread development of cyclothemic deposits in other late Paleozoic basins as well as in the Dunkard requires explanation. The synchroneity of cyclothem development throughout wide areas as well as other cyclothem characteristics prevents acceptance of any theories of local control; theories of regional diastrophism involve unknown tectonic mechanisms and do not explain certain other patterns of cyclothem development and occurrence; glacial-eustatic theories require repeated formation, as yet unverified, of continental glaciers and involve subsidiary assumptions about climatic fluctuations. Some characteristics of Dunkard (and possibly other) cyclothems, particularly the evidence for concurrent channel cutting and interchannel deposition, suggest that the increased competence of rivers resulted from changes in discharge rather than from modifications of regional slope by uplift or by lowered sea level. Climatic cycles would cause such changes in stream runoff, would account for the principal features of cyclothems, and are known to have affected late Cenozoic erosion and deposition.--Auth.

3-3837. Wilson, Charles W., Jr., and Richard G. Stearns. PENNSYLVANIAN MARINE CYCLOTHEMS IN TENNESSEE: Tennessee, Div. Geology, Rept. Inv. no. 11, 15 p., 9 figs., 1960, 13 refs.; reprinted from: Geol. Soc. America, Bull., v. 71, no. 10, p. 1451-1465, Oct. 1960.

Original paper was listed as GeoScience Abstracts 3-262.

3-3838. Carrington, Thomas J. PRELIMINARY STUDY OF RHYTHMICALLY LAYERED, TUFFACEOUS SEDIMENTS NEAR KONNAROCK, SOUTHWESTERN VIRGINIA: Mineral Industries Jour., v. 8, no. 2, p. 1-6, 6 figs., June 1961, 12 refs.

Preliminary studies of layered sediments [in upper Mount Rogers volcanic series, Precambrian] near Konnarock, indicate that there are pronounced rhythmic sequences which may be properly called rhythmites. The varied scale and complexity of the rhythmic repetitions of layers indicates to the writer that the layers cannot represent varves which they superficially resemble. It is believed that the rhythmites result from deposition by settling in relatively still water of volcanic and other material resulting from periods or cycles of volcanic activity. Large scattered rock fragments in certain of the layers are difficult to explain by any means, including ice rafting. It is hoped that additional work may confirm the writer's concept of the formation of the rhythmites. --Auth. summ.

3-3839. Chalyshev, V.I. RHYTHMIC FEATURES IN THE LOWER PERMIAN COAL-BEARING STRATA IN CENTRAL PECHORA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 510-511, May-June 1959, pub. 1960, 5 refs.

The regressive phases of the central Pechora cyclothems generally show thicker, lighter, and less well-defined bedding than the transgressive phases. Calcareous concretions are common in the regressive phase, in contrast to the transgressive phase. The latter shows much better developed and preserved fauna. It is concluded that depositional conditions in central Pechora were similar to those in the Kuznetsk basin.--F. Manheim.

3-3840. Tikhvinsky, I.N. EVOLUTIONARY CHANGES OF SALINITY IN THE ASSELIAN-SAKMARIAN SEA OF SOUTHERN TATARIA AND THE ADJOINING REGIONS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 505-509, 4 figs., May-June 1959, pub. 1960, 8 refs.

A study of the vertical and horizontal changes in lithology and fauna in the Tastubian strata [Early Permian] indicates that a single large lagoonal basin with high salinity was present in the investigated region, not a system of lagoons as has been suggested by many workers. Periodic, weak increases in salinity were especially marked in northeastern Tataria, where brachiopods, crinoids, and corals appeared at the beginning of middle Tastubian time, concurrently with the deposition of calcareous sediments. The cause of the salinity variations was probably a shallow water barrier of tectonic origin in the region of the Tataria arch. --F. Manheim.

3-3841. Korobov, S.S., and M. Diarov. THE EFFECT OF TECTONICS ON THE LITHOLOGY OF HALOGENIC DEPOSITS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 475-477, 4 figs., May-June 1959, pub. 1960, 5 refs.

Investigation of tectonized salt structures in the Kurgantau series of the Inder region found a close relationship between injections of preobrazhenskite and carnallite in halite and the development of lenses of K and K-B salts. The development of such injections is characterized by brecciated zones and active growth of boudinage structures. It is particularly noted that every known locality with B-bearing halite is adjacent to districts with widespread occurrence of K salts.--F. Manheim.

3-3842. Meng, Hsiang-Hua. THE PETROGRAPHY OF PHOSPHORITES OF THE KARATAU BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 524-526, fig., May-June 1959, pub. 1960, 9 refs.

A discussion of various types of classification of the Karatau basin phosphorites is given. Criteria for classification include angle of the bedding planes, structural type, and chemical composition. All 3 of these criteria are essential factors in interpretation of the genesis of the deposits. Oolitic phosphorites were evidently accumulated only in mobile zones in shallow-water regions, while clay-siliceous phosphorites were formed in relatively deep water under conditions apparently similar to those giving rise to the formation of the Phosphoria beds of the U.S.A. The source of the P is uncertain but a volcanic origin is suggested. --F. Manheim.

3-3843. Taft, William H. AUTHIGENIC DOLOMITE IN MODERN CARBONATE SEDIMENTS ALONG THE SOUTHERN COAST OF FLORIDA: Science, v. 134, no. 3478, p. 561-562, 2 figs., Aug. 25, 1961, ref.

Crystalline authigenic dolomite in shallow-water marine sediments from the margins of the North American continent is described for the first time. Dolomite is probably forming at the water-sediment interface in Florida Bay because of an interaction between organic material and hypersaline sea water.--Auth.

3-3844. Lucia, F.J. DEDOLOMITIZATION IN THE TANSILL (PERMIAN) FORMATION: Geol. Soc. America, Bull., v. 72, no. 7, p. 1107-1109, 5 illus., July 1961, 5 refs.

Lenses of lacy calcite with included dolomite in the calcite crystals are found in the Permian Tansill formation, Texas-New Mexico. The crystal form of anhydrite is outlined by the distribution of these inclusions suggesting that the calcite has replaced anhydrite. Replacement of dolomite by calcite is suggested by the decrease in the number of dolomite inclusions toward the edge of the calcite crystals.--Auth.

3-3845. Eliseev, A.I. THE ORIGIN OF THE CARBONIFEROUS LIMESTONE BRECCIAS OF THE CHERNYSHEV RIDGE: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 440-442, May-June 1959, pub. 1960, 8 refs.

The Carboniferous limestone breccias of the Chernyshev ridge consist of angular, 3 to 50 cm. limestone fragments accumulated in unsorted, highly compacted masses up to 10 m. thick. The breccia layers are interlayered with normal limestones of variable thickness. Tectonic and karst hypotheses cannot explain the transitional characteristics and stratified nature of these deposits, and it is concluded that they were formed by sedimentary processes, complicated by submarine earthquakes, in tectonically active areas of the sea bottom.--F. Manheim.

3-3846. Barghoorn, Elso S., and Robert L. Nichols. SULFATE-REDUCING BACTERIA AND PYRITIC SEDIMENTS IN ANTARCTICA: Science, v. 134, no. 3473, p. 190, table, July 21, 1961, 5 refs.

Black lacustrine and marine sediments occur in the McMurdo Sound region of Antarctica. The black color is due to the presence of iron sulfide, precipitated by sulfate-reducing bacteria (Desulfovibrio) in the presence of decaying organic matter of algal origin. Viability of sulfate-reducing bacteria in the sediments was demonstrated in the laboratory by culturing in anaerobic liquid media. It is probable that sulfate-reducing bacteria are widely distributed in Antarctica.--Auth.

11. GEOHYDROLOGY

See also: Geophysics 3-3701; Fuels 3-3902.

3-3847. Hantush, Mahdi S. DRAWDOWN AROUND A PARTIALLY PENETRATING WELL: Am. Soc. Civil Engineers, Hydraulics Div., Jour. v. 87, no. HY4, p. 83-98, 3 figs., table, July 1961, 16 refs.

Equations of unsteady drawdown around a well partially screened in and steadily discharging from an artesian aquifer of uniform thickness and uniform hydraulic properties are developed. The discharge is supplied by the reduction of storage through expansion of water and the concomitant compression of the aquifer. The solutions are put in forms amenable to relatively simple computation. The results are compared with that of the case of complete penetration. Application of the theory to analysis of aquifer tests will be given in a subsequent paper.--Auth.

3-3848. Campenni, Louis G. SYNTHETIC DETERGENTS IN GROUND WATERS: Water & Sewage Works, v. 108, no. 5, p. 188-191, May 1961; no. 6, p. 210-213, June 1961.

Synthetic detergents are fast becoming a growing pain of high density housing which relies upon closely spaced individual septic systems and ground-water supplies. In excess of 1 p.p.m. "syndets" contamination causes the ground-water supply to foam and to have deleterious taste and odors; and as tracers they indicate that bacterial sewage and other chemical contaminants may be expected. Little is known about their toxicity. They tend to increase in concentration with time since they are highly resistant to biochemical degradations. Evidence has shown that syndets can travel up to 95 ft. deep and 1,000 ft. horizontally, principally in the direction of ground-water flow.

In Suffolk County, Long Island, an investigation of industrial Cr waste contamination in a nearby 300 house community revealed up to 1.4 p.p.m. of syndet in one-third of the individual well water systems. These were bored 14 to 56 ft. deep into a nearsurface very permeable sand and gravel glacial stratum having a water table at 7 to 12 ft. Additional contaminants included abnormal concentrations of chlorides and nitrates with high O consumed tests.

The town of Portsmouth, Rhode Island, discovered that in a 50 house subdivision, of the 25 wells tested, 24 had syndet pollution ranging from 0.15 to 5.0 p.p.m. with the highest amount in a 250-ft. well. Nitrates and bacterial sewage were also found. The subdivision was founded upon 10 ft. of impermeable till underlain by Carboniferous shale with the wells drilled from 100 to 300 ft. and the ground-water table at 10 to 15 ft. deep.

In both cases the U. S. Federal Housing Administration and the state health departments investigated and imposed controls to eliminate such difficulties. These controls included: establishment of minimum 20,000 sq. ft. lot sizes, elimination of subdivisions in such areas, rigid control of the depth of the well below the water table, testing of the water before the supply is approved, careful control of drilling and completing procedures, and restriction of combination septic system and ground-water supplies in areas of syndet problems.--J. E. Garrison.

3-3849. Ryling, Roy W. A PRELIMINARY STUDY OF THE DISTRIBUTION OF SALINE WATER IN THE BEDROCK AQUIFERS OF EASTERN WISCONSIN: Wisconsin Geol. & Nat. History Survey, Inf. Circ. no. 5, 23 p., 6 figs., 2 tables, 1961, 11 refs.

The bedrock aquifers that are sources of water supply in eastern Wisconsin are, from oldest to youngest, the undifferentiated sandstones of Late Cambrian age; the Prairie du Chien group, St. Peter sandstone, and the Platteville-Galena unit of Ordovician age; and the Niagara dolomite of Silurian age.

Sulfate occurs in ground water in quantities exceeding 250 p. p. m. in 6 areas in eastern Wisconsin. Three of these are along the eastern edge of the area of investigation, centering in northeastern Manitowoc County (1,790 p. p. m. maximum recorded), central Sheboygan County (2,050 p. p. m. maximum), and eastern and northern Milwaukee County (2,250 p.p.m. maximum). A fourth area covers much of western Calumet County and parts of Brown, Outagamie, Winnebago and Fond du Lac counties (954 p.p.m. maximum). Two small areas are in northeastern Dodge County (2,900 p.p.m. maximum) and southeastern Marinette County (687 p.p.m. maximum). Ground water containing more than 250 p.p.m. sulfate occurs in about 10.6% of the mapped area. The regional pattern of distribution shows increasing concentrations of sulfate eastward.

Chloride occurs in ground water in quantities exceeding 250 p.p.m. in 3 areas in eastern Wisconsin - E. -central Sheboygan County (with 4,310 p.p.m. maximum recorded), northern Milwaukee County (1,890 p.p.m. maximum) and northeastern Dodge County (438 p.p.m. maximum). Chloride concentrations exceeding 250 p.p.m. occur in only about 0.4% of the area mapped.

Concentrations of dissolved solids exceeding 1,000 p.p.m. occur in the same general areas as those of excessive sulfate. In the area centering in northern Manitowoc County, the maximum recorded concentration of dissolved solids is 3,550 p.p.m. In central Sheboygan County and northern Milwaukee County, the maximum concentrations are 10,440 and 6,690 p.p.m., respectively. In western Calumet County and parts of Brown, Outagamie, Winnebago, and Fond du Lac counties, the maximum concentration of dissolved solids is 1,980 p.p.m. In northeastern Dodge and southeastern Marinette counties, water analyses indicate maximum concentrations of 5,730 and 1,220 p.p.m. respectively. Ground water that contains concentrations of dissolved solids exceeding 1,000 p. p. m. occurs in 9.1% of the area mapped. The regional pattern of distribution shows increasing concentrations of dissolved solids eastward.

The locations of the 3 areas of saline ground water in Manitowoc, Sheboygan, and Milwaukee counties generally coincide with probable structural lows in the water-bearing bedrock units of Late Cambrian and Ordovician age.

Along the geologic section from Outagamie County to Manitowoc County, the concentrations of sulfate, chloride, and dissolved solids increase rapidly immediately updip from a ridge of Precambrian rock that extends upward several hundred feet into the Upper Cambrian series. Further updip and immediately downdip from this ridge, the ground water is fresh. This high, therefore, appears to form a partial barrier to the eastward movement of ground water. The Niagara dolomite and the Upper Cambrian series yield saline water to wells in eastern Manitowoc County. Wells uncased opposite the Platteville-Galena unit, the St. Peter sandstone, and the Upper Cambrian series yield saline water to wells immediately updip from the W. of the ridge of Precambrian rock.

Two subsurface ridges of Precambrian rock that must have considerable relief but are of small lateral extent extend from Fond du Lac County to Sheboygan County. Concentrations of dissolved solids are higher updip from and within the ridge area than they are 10 mi. downdip from the easternmost ridge. The Niagara dolomite yields water of relatively poor quality to wells in central and eastern Sheboygan County. The St. Peter sandstone contains saline water in eastern Sheboygan County.

From Jefferson County to Milwaukee County there are no significant partial stratigraphic barriers to the regional direction of ground-water movement. The changes in the chemical quality of the water as it moves downdip through the aquifers possibly would represent the general conditions in the previously discussed areas had there been no high ridges of Precambrian rock. In eastern Waukesha and northwestern Milwaukee counties, the Niagara dolomite yields predominantly fresh water to wells. In northeastern Milwaukee County, a well tapping the Niagara dolomite, the Platteville-Galena unit, and the St. Peter sandstone yields saline water.--Auth. summ. & concl.

3-3850. Fairchild, M. G., and others. CLEAR LAKE-CACHE CREEK BASIN INVESTIGATION: California, Dept. Water Resources, Bull. no. 90, 267 p., 16 illus., 2 figs., 19 pls., 55 tables, March 1961.

This report contains an inventory of surface- and ground-water resources of the Clear Lake-Cache Creek basin in central California and presents a comprehensive plan for the development of the water resources of the area.

Ground water in the Cache Creek Basin area, along the W. side of Sacramento Valley, occurs mainly in a thick section of water-bearing sediments ranging in age from Plio-Pleistocene to Recent. The Tehama formation and related continental sediments of Plio-Pleistocene age, underlies the entire area and consists of sediments with low to moderate permeability. Older alluvium of Pleistocene age blankets the Tehama formation. The basal section of this unit is coarse-grained and highly permeable; the upper section is fine-grained and low in permeability. Younger alluvium and stream channel deposits are limited in areal extent. These deposits are moderate to high in permeability and are capable of absorbing and transmitting rainfall and excess irrigation water to the underlying water-bearing formations. Total ground-water storage capacity in the depth interval 20 to 200 ft. is approximately 2,383,800 acre-ft.

Ground water in the area is largely unconfined and in 1959 stood at an average depth of 35 ft. below ground surface. With the exception of minor ground-water ridges and troughs, ground water moves eastward from the central Coast Ranges towards the trough of the Sacramento Valley. Ground water is generally hard or very hard calcium bicarbonate in character and is typed as good to poor throughout the basin primarily because of the B concentration.--R. C. Richter.

3-3851. Leve, Gilbert W. PRELIMINARY INVESTIGATION OF THE GROUND-WATER RESOURCES OF NORTHEAST FLORIDA: Florida Geol. Survey, Inf. Circ. 27, 28 p., 11 figs., 2 tables, 1961.

This report describes an area of about 2 sq. mi. in NE. Florida and SE. Georgia. The principal source of water in the area is permeable limestones of Eocene age. The top of the limestone of Eocene age was found to be 570 ft. below the land surface in well 026-126-1, 16 mi. NE. of Jacksonville, and 550 ft. below the land surface in well 038-127-3, 3 mi. SW. of Fernandina Beach. These limestones are overlain by the Hawthorn formation of middle Miocene age, which consists of beds of sandy clay and clayey sand containing limestone and dolomite lenses. The Hawthorn formation is overlain by undifferentiated deposits of sand, clay, marl, and shell of undetermined age. Impermeable beds in the Hawthorn formation and post-Hawthorn deposits serve as confining beds for the artesian water in the underlying limestones of Eocene age.

The principal recharge area to the artesian aquifer in NE. Florida is in the vicinity of a piezometric high that extends from northwestern Putnam County, through western Clay, Bradford, Union, and Baker counties into Georgia. From this recharge area, the piezometric surface slopes generally northeastward into NE. Florida toward discharge areas in Duval and Nassau counties.

Cones of depression have developed in the piezometric surface in Fernandina and in the vicinity of Jacksonville as a result of discharge of artesian water by municipal and industrial wells. Between 1880 and Jan. 1960, the decline of the piezometric surface in NE. Florida has ranged from about 10 ft. to more than 60 ft., and there has been a great enlargement of the cones of depression since 1943.

Variations in discharge of industrial and municipal wells commonly cause the water levels in nearby wells to fluctuate more than 10 ft. Long-term trends in water levels can be attributed to a combination of cyclic trends of rainfall in recharge areas and an increase in both seasonal and perennial use of water in discharge areas. Water levels in wells throughout NE. Florida generally declined between 1940 and 1956 or 1957 because of a deficiency in rainfall and increased discharge of artesian water. Water levels rose from 4.5 to 12 ft. between 1956 or 1957 and Jan. 1960 in response to average to above average rainfall, but because of increased pumpage they remained well below previous recorded high water levels.

Presently, the rate of discharge at Fernandina and in the vicinity of Jacksonville does not exceed the perennial yield of the aquifer. However, with an expansion of industry and an increase in population in NE. Florida, the rate of discharge of artesian water can be expected to increase. At some future date, the rate of discharge may exceed the normal rate of recharge, and water levels may again continue to decline even during cycles of average rainfall.

The chloride content of the water is less than 20 p.p.m. (parts per million) in wells in the southwestern part of the area where the piezometric surface is highest and more than 30 p.p.m. in wells in northern Duval and northern Nassau counties where the piezometric surface is lowest. The chloride content of the water was 860 p.p.m. in Sept. 1959 in a well located near the center of the cone of depression at Fernandina. The chloride content of water from most artesian wells increased from 1 to 13 p.p.m. since 1940, and the chloride content of water from well 038-127-3 has increased more than 220 p.p.m. from Apr. 1956 to Sept. 1959.

Most water samples analyzed during this investigation did not indicate sufficient chloride content to endanger the industrial or municipal supplies. However, if the artesian pressure declines below the record lows of 1956 and 1957, contamination of fresh-water supplies might increase until eventually these supplies might become unsuitable for industrial and municipal use.--Auth.

3-3852. Giroux, P. R., and Ted Thompson. SUMMARY OF GROUND-WATER CONDITIONS IN MICHIGAN, 1959: Michigan, Geol. Survey Div., Water Supply Rept. no. 4, 69 p., 21 figs., 2 tables, 1959, pub. [1960?], 11 refs.

This report is based on periodic measurements of water levels made during 1959 in 188 wells of which

38 were equipped with continuous recording gages. Measurements of water level in some of the wells were discontinued in areas where intensive investigations had been in progress and where the results of findings have now been made public. The report summarizes water-level changes observed throughout the state, and analyzes these changes in selected areas.

The basic information for each observation well, and extremes of water-level fluctuations in 1959 and for the previous period of record are listed. Fluctuations of water levels in representative wells are shown by numerous hydrographs, and in many cases graphic interpretations of the changes in water level are made by including pertinent climatic and/or pumpage data. Also listed are reported monthly and annual ground-water pumpage for various municipalities, institutions, and industries in the state.--From auth., p. 3.

3-3853. Moore, John E. RECORDS OF WELLS, TEST HOLES, AND SPRINGS IN THE NEVADA TEST SITE AND SURROUNDING AREA: U. S. Geol. Survey, Trace Elements Inv. Rept. 781, 22 p., map (in pocket), 5 tables, 1961, 14 refs.

Since Nov. 1957 the U. S. Geological Survey, on behalf of the U. S. Atomic Energy Commission, has been collecting and compiling all available information on the source, occurrence, quality, quantity, temperature, and other aspects of the ground-water resources of the Nevada Test Site and the surrounding area. This report summarizes the basic information that has been collected on 49 wells and test holes from this area, together with information on 9 springs.

The rocks exposed in the Nevada Test Site consist of varied sedimentary rocks of Paleozoic age, volcanic and sedimentary rocks of Tertiary age, and alluvial and playa deposits of Quaternary age. The Paleozoic rocks have a total thickness of about 22,000 ft. and are dominantly limestone and dolomite, together with marble, quartzite, argillite, shale, and conglomerate. The Paleozoic rocks have been intruded at a few places by a granodiorite stock and by sills, of Cretaceous or Tertiary age. The overlying Tertiary rocks consist principally of vitric and zeolitic tuff, basalt, rhyolite, and rhyodacite of the Oak Spring formation of Miocene(?) or younger age. The Tertiary and Quaternary alluvium consists principally of detritus deposited in the intermontane basins, much of it in the form of fans.

The principal aquifers at the Nevada Test Site are in the Oak Spring formation and the alluvial deposits. Among the Paleozoic rocks, the marble of the Pogonip group, of Ordovician age, is believed to be capable of yielding water, although to date no well produces from it.--From auth., p. 3-5.

3-3854. Schoff, Stuart L., and Isaac J. Winograd. HYDROLOGIC SIGNIFICANCE OF SIX CORE HOLES IN CARBONATE ROCKS OF THE NEVADA TEST SITE: U.S. Geol. Survey, Trace Elements Inv. Rept. no. 787, 97 p., 4 figs., 9 tables, July 1961.

Six core holes drilled in the northern part of Yucca valley, Nevada Test Site, penetrate carbonate rocks of Paleozoic age to depths of hundreds of feet. Although none reaches the regional water table, 2 enter a perched zone of saturation in marble. Several lines of evidence suggest that the carbonate rocks, if saturated, would yield water to appropriately constructed wells penetrating them. Yields per well of 6 g.p.m., or more, may be expected. Wells need not be abandoned as futile solely because they have entered the carbonate rocks without finding water.--Auth.

3-3855. Bjorklund, Louis J., and Bruce W. Maxwell. AVAILABILITY OF GROUND WATER IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, NEW MEXICO: New Mexico, State Engineer, Tech. Rept. 21, 117 p., 13 figs., 6 pls., 8 tables, 1961, 64 refs.

The Albuquerque area covers about 1,400 sq. mi. It extends from Algodones and the N. side of the Jemez River valley on the N. to Isleta and the Valencia County line on the S. and from the Sandia and Manzano mountains on the E. to the Rio Puerco on the W.

Water diverted from the Rio Grande has been a mainstay of life for hundreds of years in the Albuquerque area. The State Engineer in 1956 declared the Rio Grande Underground Water Basin to protect the surface- and ground-water resources from being overdeveloped.

The Albuquerque area lies mostly within the Rio Grande depression, which is a series of grabens and structural basins having a general N.-S. alignment and which is bordered on the E. and W. by upfaulted blocks. Igneous, metamorphic, and sedimentary rocks exposed in the Albuquerque area range in age from Precambrian to Quaternary. Rocks older than Tertiary are exposed in the Sandia and Manzano mountains to the E. and in the Rio Puerco valley and on the highlands W. of the Zia Indian Reservation. These older rocks yield relatively small quantities of water to wells in the area.

The grabens or valleys have been filled partly by sand, gravel, silt, clay, and volcanic rocks of Tertiary and Quaternary age. In places the sediments, which are unconsolidated to loosely cemented, are more than 6,000 ft. thick. All water wells of large capacity are finished in the sedimentary rocks.

Ground water in the valley fill generally occurs under water-table conditions. Sediments E. of the inner valley generally are more permeable than sediments underlying or W. of the inner valley. Coefficients of transmissibility determined at tested wells in the valley fill ranged from 7,500 to 600,000 g.p.d (gallons per day) per ft., and average permeabilities at wells ranged from 13 to 840 g.p.d. per sq. ft.

Water is pumped from wells for public, irrigation, industrial, commercial, domestic, and stock uses. Wells of large yield usually are drilled at least 200 ft. into water-bearing material. The specific capacity of most large-discharge wells ranges from 20 to 100 g.p.m. (gallons per minute) per ft. of drawdown, and the average specific capacity of 66 selected wells was 44 g.p.m. per ft. The municipal water system of the city of Albuquerque is supplied from 77 wells ranging in depth from 65 to 1,284 ft. The average daily pumpage in Albuquerque increased from 2 m.g.d. (million gallons per day) in 1930 to 34 m.g.d. in 1959. The town of Bernalillo is supplied by 2 wells. Several schools, hotels, hospitals, public buildings, and government installations in and near Albuquerque are supplied with water from privately and institutionally owned wells. Many industries and commercial institutions obtain their water from privately owned wells. Large-discharge irrigation wells are used on farms, both as a sole source of water and to supplement existing surface-water supplies. Many small-discharge driven irrigation wells are used to irrigate small farms and gardens. The total pumpage in the area in 1959 was about 63,000 acre-ft.

The water table slopes diagonally downvalley from the bases of the Sandia and Manzano mountains on the E. and from the Rio Puerco on the W. toward a ground-water depression, or "trough," about 8 mi. W. of the Rio Grande. The trough extends southward into Valencia County. A ground-water mound masks the trough beneath the Jemez River valley. The water table beneath the inner valley slopes southward at approximately the same gradient as the river. Another ground-water depression has been formed near downtown Albuquerque by pumping from wells.

Water levels beneath the inner valley have lowered significantly since drains were constructed in 1930. Ground-water levels have declined beneath downtown Albuquerque and in a few other centers of heavy pumping. Levels will decline further in the Albuquerque area if the annual pumping rate increases, but will stabilize at some lower level within a few years after the annual pumping rate becomes constant.

The depth to water below the land surface in most of the inner valley is between 5 and 10 ft. but beneath downtown Albuquerque it is as much as 29 ft. The depth to water beneath the "E. mesa" increases eastward to as much as 600 ft., and beneath the "W. mesa" it increases westward to as much as 1,000 ft. Depths to water in the Jemez River valley are shallow but increase northward and southward from the river.

The ground-water reservoir is recharged by infiltration of precipitation; by seepage from streams, drains, canals, and surface reservoirs; by infiltration of applied irrigation water; and by underflow of ground water from adjacent areas. Much water seeps to the ground-water reservoir from the Rio Grande and the Jemez River, and from ephemeral streams, especially in the upper parts of alluvial fans near the mouths of canyons. Drains contribute water to the ground-water reservoir in places where the water table is lower than the drains. Probably about a third of the water pumped from wells for irrigation returns to the ground-water reservoir. Rates of seepage from 2 wetted land-surface areas on the W. mesa were 2.6 and 1.6 acre-ft. per acre per day. Rates of seepage from pits were 10 to 13.7 acre-ft. per acre per day.

Water is discharged from the ground-water reservoir through springs and seeps, drains, and wells, and by evapotranspiration. Many small springs discharge into canyons and arroyos along the face of the Sandia and Manzano mountains, but this water either is evaporated and transpired or returns to the ground-water reservoir to be discharged elsewhere. About 100 mi. of drains prevent the waterlogging of land on the valley floor. About 18 sq. mi. of the inner valley is covered with cottonwood, willow, and saltcedar which use an average of about 4 acre-ft. of water per acre per year.

Water in the area is chemically suitable for most uses, although surface waters usually contain suspended sediments. Of 68 ground-water samples collected from sediments of Tertiary age, 61 were fresh, 6 were slightly saline, and 1 was moderately saline. Water in sediments of Quaternary age usually is more mineralized than water in the older valley fill. The chemical quality of water in deposits of Quaternary age has improved since the construction of drains in 1930. The chemical quality of water in the Rio Grande is good.

The temperature of water in wells in the Albuquerque area ranges from 51° to 90°F. The low temperatures are attributed to recharge of cold water from streams. The causes of the higher temperatures are not known but may be volcanism or faulting.--Auth.

3-3856. Texas, Board of Water Engineers. RECONNAISSANCE INVESTIGATION OF THE GROUND WATER RESOURCES OF THE CANADIAN RIVER BASIN, TEXAS: Its: Bull. 6016, 27p., fig., 4 pls., 6 tables, Sept. 1960, 41 refs.

The reconnaissance study of the Canadian River basin was undertaken as part of a statewide program designed to provide the general order of magnitude of ground-water supplies potentially available from the principal water-bearing formations of Texas. The basin area defined for the study covers about 13,000 sq. mi. from the divide between the Red and Canadian River basins N. to the state line.

The availability and use of ground water in the Canadian River basin is influenced strongly by arid to semi-arid climatic conditions featured by low rainfall, high evaporation losses, and frequent strong winds. The development of irrigation in the area can be traced largely to the impetus given its growth during periods of deficient rainfall, although dry-land farming is practiced with moderate success during periods of normal rainfall.

The principal aquifer in the basin is the Ogallala formation of Tertiary age, although significant quantities of water are also found in Cretaceous and Triassic rocks. The Ogallala is a stream-deposited formation composed of interconnected sands and gravels which form a large unconfined ground-water reservoir. It ranges in thickness in the basin area from 0 to 900 ft., and is found over most of the basin. The thickness of saturated material is closely related to the thickness of the formation.

Water occurring under artesian conditions in the Dakota sandstone of Cretaceous age supplies irrigation wells and municipal demands in northwestern Dallam County. Fresh water in Triassic and Permian rocks is similar in quality to the water in the Ogallala and probably moved into the older beds from the Ogallala where they are in contact. No appreciable supplies of water are found in the Quaternary sediments although some of these deposits at the surface offer favorable conditions for recharge to underlying beds.

Recharge to the Ogallala formation is from rainfall and snow in Texas and New Mexico. Less than 1 in. annually of such precipitation reaches the water table as recharge to storage. Preliminary studies indicate that no appreciable quantities of water reach the ground-water reservoir through infiltration from depression ponds that dot the High Plains. Ground water moves generally eastward through the Ogallala. The normal gradient of the water table is generally about 10 ft. per mi., with steeper gradients in areas of heavy pumpage and near valleys cut through the water table.

In 1958 there were 1,356 irrigation wells, 116 municipal wells, and 118 industrial wells in the basin. Yields from about 10% of the irrigation wells in the basin ranged from 204 to 1,225 g.p.m., drawdowns from 17.5 ft. to 170.3 ft., and specific capacities from 2.9 to 62.6 g.p.m. per ft. of drawdown. The depth to water in the basin ranges from 0 in stream valleys to about 400 ft. The average annual decline of water levels in wells was less than 1 ft. for the period of record.

The quality of water in the Ogallala rocks, based on analyses of samples from 33 municipal wells, is generally suitable for most purposes, although some of the samples analyzed revealed undesirable concentrations of hardness, Fe, silica, and fluoride. Water from the older formations is variable in quality and may be unsuitable for use.

The present annual irrigation, municipal and industrial pumpage of ground water exceeds the rate of replenishment of the reservoir, so that reductions of water in storage are occurring. There was estimated to be more than 200 million acre-feet of water in storage in the Canadian basin portion of the Ogallala in 1958, and the rate of withdrawal for all purposes in the same year was about 520,000 acre-ft.

Future additional water uses in any area in the basin will be conditioned in part on the thickness of saturated sands and gravels available. At an assumed rate of annual replenishment of 0.1 acre-ft. per acre per year, which is probably an optimistic estimate, and an assumed average use for irrigation from 1958 to 1975 of one and one half times the 1958 rate of withdrawal, the amount of water available in storage underlying the plains area in 1958 would be depleted by 6.5 million acre-ft. by 1975, which is about 3% of the estimated total amount in storage in 1958.--Auth.

3-3857. Long, A. T., Jr. GEOLOGY AND GROUND-WATER RESOURCES OF CARSON COUNTY AND PART OF GRAY COUNTY, TEXAS, PROGRESS REPORT NO. 1: Texas, Board Water Engineers, Bull. 6102, 45 p., 11 figs., 5 pls., March 1961, 24 refs.

The first report on an investigation of an area of about 1,400 sq. mi. approximately in the center of the Panhandle of Texas. The economy of the area depends largely on ground water. Almost all the plains area is under cultivation. Irrigation farming began in 1953 as a result of the drought. Industrial development became important after the expansion of the Panhandle oil field in 1926. Natural gas in abundance is a cheap fuel for pumping irrigation wells.

The Ogallala formation of Pliocene age, underlying the plains and part of the breaks, is the principal aquifer. The Ogallala, deposited on older rocks of Triassic and Permian age, is more than 900 ft. thick in western Carson County. It consists of sand, silt, clay, and gravel, the thicker sections generally containing more of the coarser material. The water occurs generally under water-table conditions, but in a few places it appears to be under artesian pressure. Sediments of Quaternary age on the surface of the plains and along streams are above the water table in most places and supply practically no water to wells.

Precipitation in Carson and Gray counties is the source of nearly all of the ground water in the area. A barrier to the movement of ground water in southwestern Carson County and a ground-water divide in eastern Potter County limit the amount of underflow into the area.

The increase in the use of water by industries and cities followed the expansion in industry, the greatest increase being since 1940. The establishment of well fields some distance from cities followed their rapid growth, especially in the last decade.--Auth.

3-3858. Cronin, James G., and Lloyd C. Wells. GEOLOGY AND GROUND-WATER RESOURCES OF HALE COUNTY, TEXAS: Texas, Board Water Engineers, Bull. 6010, 149 p., 17 figs., 3 pls., 6 tables, Nov. 1960, 20 refs.

Hale County, in the southern High Plains of Texas, has an area of 1,033 sq. mi. The land surface is one of low relief, the regional slope being about 10 ft. per mile toward the SE. Surface runoff drains into numerous playa lakes and 2 intermittent streams, Running Water Draw and the Double Mountain Fork of the Brazos River.

The Ogallala formation of Tertiary age is the principal water-bearing formation in the county. The Ogallala lies on red beds of Triassic age throughout most of the county and on rocks of Cretaceous age in approximately the southern fifth of the county. The Triassic and underlying Permian rocks are not fresh-water bearing in the county. The Cretaceous rocks, on the other hand, are in direct hydraulic connection with the Ogallala, and a few wells tapping them yield large quantities of water from cracks and solution channels in the limestones. The Ogallala formation is overlain by thin deposits of sand, gravel, silt, and clay of Pleistocene and Recent age. These younger rocks are, for the most part, above the water table and consequently, are nonwater bearing.

The water in the Ogallala formation occurs principally as unconfined water in layers and lenses of sand and gravel. The hydraulic properties of the Ogallala were determined by a long-term aquifer test at Plainview where coefficients of transmissibility ranging from 24,000 to 38,000 g.p.d. (gallons per day) per ft. were measured. The coefficient of storage was determined to be about 0.14. The aquifer is recharged from precipitation in Hale County and in the southern High Plains NW. of the county. The water moves generally southeastward at about 2 inches a day.

Ground water in Hale County is used principally for irrigation. In 1955 more than 3,700 wells were used to irrigate 470,000 acres, about 560,000 acre-ft. of water being pumped. About 5,000 acre-ft. was pumped for other purposes including minicipal, industrial, stock, and domestic uses. The water in the Ogallala formation in Hale County is suitable chemically for irrigation and most other uses; however, it should be softened for more satisfactory domestic uses. The high silica content indicates that the water may be unsuitable for use in boilers. The fluoride content is excessive.

It is estimated that in 1955 about 39 million acre-ft. of water was in storage in the Ogallala formation in Hale County; however, only about 16 million is theoretically available to wells, and a somewhat smaller amount is practically available. About 3 million acre-ft. was removed from storage from 1938 through 1955 Water levels in wells have declined more or less steadily since 1938, and it is apparent that the ground water resources of the county are insufficient to support large-scale perennial irrigation such as that of 1955.--Auth.

3-3859. Baker, Roger C., and O. C. DALE. GROUND-WATER RESOURCES OF THE LOWER RIO GRANDE VALLEY AREA, TEXAS: Texas, Board Water Engineers, Bull. 6014, 2 v., 10 figs., 14 pls. (1 in pocket, v. 2), 3 tables, Feb. 1961, 49 refs.

The report contains information about the occurrence, quality, and use of ground water in the lower Rio Grande Valley area which consists of Cameron, Hidalgo, Starr, and Willacy counties in southern Texas. Vol. 2 contains well records, drillers' logs, water levels, and analyses of water. The principal use of water is for irrigation. Cotton, winter vegetables, and citrus fruits are the most widely irrigated crops. In southeastern Starr County, southern Hidalgo County, and western Cameron County, most of the water for all uses is supplied by the Rio Grande. The greatest development of ground water in this area was after 1948 when ground water was needed to supplement water from the river.

The Lower Rio Grande Valley area has 4 major ground-water reservoirs. Three of these reservoirs have been given names in this report because stratigraphic units could not be reliably mapped and because some of the ground-water reservoirs include parts of 2 or more formations. Major ground-water reservoirs are the Oakville sandstone, which is an important source of water for industrial use in northeastern Starr County; the Linn-Faysville ground-water reservoir, which supplies irrigation water in the Linn-Faysville area in central Hidalgo County; and the Rio Grande ground-water reservoir and the Mercedes-Sebastian shallow ground-water reservoir, both of which supply considerable irrigation water in southeastern Starr, southern Hidalgo, western Cameron, and southwestern Willacy counties.

The quality of ground water differs considerably in the lower Rio Grande Valley area. In most of the area ground water, although slightly saline, is available for domestic or public supply; however, it is generally unsuitable for irrigation, particularly if used exclusively. Water of the best quality is from the Rio Grande ground-water reservoir near the Rio Grande at depths of less than 75 ft. in southeastern Starr County, between 50 and 250 ft. in southern Hidalgo County, and between 100 and 300 ft. in western Cameron County. At progressively greater distances from the Rio Grande, ground water at these depths tends to be more mineralized. In the Linn-Faysville area ground water from the Linn-Faysville ground-water reservoir is moderately mineralized and ranges from fair to unsuitable for irrigation.

In western Cameron County water levels in some wells tapping the Rio Grande ground-water reservoir declined about 10 ft. from 1954 to 1957. In 1959 the water levels stood higher than in 1954. The water levels in most wells tapping the Linn-Faysville ground-water reservoir declined 10 ft. or more from 1948 to 1958. In some wells the decline was more than 15 ft.

Available information indicates that in some localities the Rio Grande ground-water reservoir may be nearly filled to capacity, and waterlogging will occur during periods of above normal precipitation. During protracted periods of below normal precipitation, available water in the ground-water reservoir may be depleted. Continuing studies of fluctuations in water levels and the amount and distribution of pumping are recommended to provide basic data needed to make quantitative evaluations of the ground-water reservoirs.--Auth.

3-3860. Mason, Curtis C. **GROUND-WATER GEOLOGY OF THE HICKORY SANDSTONE MEMBER OF THE RILEY FORMATION, McCULLOCH COUNTY, TEXAS: Texas, Board Water Engineers, Bull. 6017, 84 p., 14 figs., pl., 6 tables, Feb. 1961, 13 refs.**

McCulloch County in central Texas has an area of 1,066 sq. mi. and had a population of 11,701 in 1950. The economy of the county is dependent chiefly upon farming and ranching, irrigation farming being practiced in the southeastern part. The climate of the county is subhumid, the average annual precipitation being about 24 in.

The county is underlain by Precambrian rocks consisting of granite, schist, and gneiss. These are overlain in most of the county by Paleozoic and Mesozoic sandstone, limestone, and shale. The principal aquifer in the county is the Hickory sandstone member of the Riley formation of Cambrian age, which has an average thickness in the outcrop area of 360 ft. Throughout the rest of the county the thickness is about 400 ft. The Hickory underlies all the county except for a small area in the SE. corner, where it crops out in a narrow belt surrounding the outcrop of Precambrian rocks. The Hickory sandstone member dips northward and northwestward at about 120 ft. per mi.

Water occurs under water-table (unconfined) conditions in much of the outcrop area of the Hickory sandstone member and under artesian (confined) conditions in the rest of the county. Pumping tests indicate a coefficient of transmissibility of about 30,000 g.p.d. (gallons per day) per ft. in the outcrop area and about 20,000 g.p.d. per ft. at Brady. The coefficient of storage at Brady is about 0.0001.

In 1958 about 3,200 acre-ft. of water was pumped from the Hickory in McCulloch County. About 1,600 acre-ft. was pumped by the city of Brady, and about 1,200 acre-ft. was used to irrigate about 1,200 acres in the southeastern part of the county. The rest was used for industrial, domestic, and stock purposes. Recharge to the Hickory is derived chiefly from precipitation on the outcrop areas in the southeastern part of the county and in neighboring Mason County to the S. The water moves generally northward and northeastward away from the outcrop areas, much of the water ultimately leaving the county as underflow into San Saba County. About 75,000,000 acre-ft. of water is in transient storage in the Hickory in McCulloch County. Most of this water cannot be recovered through wells; however, about 1,000,000 acre-ft. would be available to wells if the water levels were lowered 500 ft. throughout the county.

The chemical quality of the water in the Hickory sandstone member is good except that the water is hard and, in a few places, the Fe content is high. Except for the high Fe content, the water meets the standards recommended by the U.S. Public Health Service for drinking water. Most of the water is of excellent quality for irrigation.--Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 3-3570, 3-3572, 3-3580, 3-3581, 3-3582, 3-3584; Areal and Regional Geology 3-3598, 3-3604; Geochemistry 3-3761, 3-3777, 3-3781, 3-3783; Mineralogy 3-3811, 3-3819; Igneous and Metamorphic Petrology 3-3825; Fuels 3-3905.

3-3861. Derry, Duncan R. **ECONOMIC ASPECTS OF ARCHAEAN-PROTEROZOIC BOUNDARIES: Econ. Geology, v. 56, no. 4, p. 635-647, 2 maps, June-July 1961, 21 refs.**

It is the author's belief that radioactive dating, following the increased accuracy and extent of determinations, is an important complement to structural mapping not only in the elucidation of Precambrian structure and history but also in the study of the distribution of certain mineral deposits. Proterozoic Fe formation and uraniferous conglomerates have been noted as examples of such deposits that appear to have a direct relationship to Archean-Proterozoic boundaries. Various other deposits, particularly of base metals, appear to have a spatial, but less direct relationship to such boundaries.

By reason of unusually good rock exposures, relatively little disturbance since Precambrian times, and a rather concentrated study over the past few years, the Keewatin nucleus of North America and its adjoining tectonic provinces may be the best model to use in the study of similar, but perhaps more complex, Precambrian areas in other parts of the world. The examples quoted give some indication that similar relationships between economic deposits and Archean-Proterozoic boundaries occur on other continents.

Large areas of Precambrian in Africa, India, and South America, the geological details often clouded by tropical weathering and vegetation, await a comprehensive study to correlate the isolated parts that have already been mapped in some detail. In Africa such areas of Precambrian extend over the political boundaries of newly independent nations, which are anxious to develop their natural resources as quickly and efficiently as possible. One of the more useful contributions that could be made by geologists familiar with the Precambrian of the North American continent would be the application to such parts of Africa, and other continents, of the emerging knowledge and patterns of certain ore deposits associated with the boundaries of the Keewatin nucleus.

This knowledge and experience should be applied on a continental rather than a national scale and should be coordinated with an extensive use of age determinations. The medium for such cooperation might, at least in the earlier stages, be one of the technical aid programs under the United Nations Organization.--From auth. concl.

3-3862. Greenwood, Robert. BARREN AND PRODUCTIVE INTRUSIVE PORPHYRY: Econ. Geology, v. 56, no. 4, p. 790, June-July 1961.

Discussion of GeoScience Abstracts 3-1697. The suggestion that the term "granite porphyry" be dropped does not seem to be adequately supported by the facts, and misses the point that the textural difference between "granite porphyry" and "porphyritic granite" usually is associated with a genetic difference as well.--J. A. Chamberlain.

3-3863. Ozerova, N. A. THE USE OF PRIMARY DISPERSION HALOS OF MERCURY IN THE SEARCH FOR LEAD-ZINC DEPOSITS: Geokhimiya, in translation, 1959, no. 7, p. 793-802, graph, sec., 3 tables, pub. 1961, 15 refs.

The primary dispersion halos of Hg were studied on the Pb-Zn deposits of the Turkestan mountain range. It is established that the width of the Hg halos over this deposit is 1-2 km. at a width of the ore zone of 50-100 m. The Hg content in the halos averages 5×10^{-6}-5×10^{-5}%, increasing directly over the deposit till ten thousandths of a percent. The dispersion halos of Hg are considerably wider than the dispersion halos of Pb.

Sphalerites and fahlores are the richest in Hg among ore minerals, barites the richest among the nonmetallic minerals.--Auth.

3-3864. Ogienko, V. S. DISTRIBUTION OF BROMINE IN THE ROCK SALT OF THE ANGARA-LENA SALT BASIN AND THE POSSIBILITY OF FINDING POTASSIUM SALTS: Geokhimiya, in translation, 1959, no. 8, p. 893-900, 6 figs., table, pub. 1961, 2 refs.

The comparison of the values of the Br-Cl coefficient with the scale of normal Br contents in crystallization products of sea water, according to the data of M. G. Valiashko, is used as a prospecting method. The direction in which the most prospective region of K and magnesian salt deposits most possibly is situated is established according to the values of the Br-Cl coefficient for rock-salt in separate pitholes of the Angara-Lena salt basin, U. S. S. R.--Auth.

3-3865. Siems, Peter L. PATTERNS TO ORES IN LAYERED ROCKS: Econ. Geology, v. 56, no. 4, p. 790-792, June-July 1961.

Discussion of GeoScience Abstracts 2-2396. It is unfortunate that much of the information presented by Professor Bain is misleading and out of date. Detailed evidence suggests that the basal reef in the Orange Free State goldfield was deposited by a sea transgressive westward, not by a meandering stream. There is little or no systematic pattern to the ore distribution.--J. A. Chamberlain.

3-3866. Titley, Spencer R. GENESIS AND CONTROL OF THE LINCHBURG OREBODY, SOCORRO COUNTY, NEW MEXICO: Econ. Geology, v. 56, no. 4, p. 695-722, 9 figs., table, June-July 1961, 14 refs.

The Linchburg mine, in the Magdalena district, is typical of the pyrometasomatic group of deposits, differing only in its lack of a known intrusive rock to which the pyrometasomatic mineralization can be related. The ore deposit consists principally of sphalerite, galena, and sparse chalcopyrite in a gangue of andradite, hedenbergite, and hematite. The ore body has been controlled by a major fault on which some 500 ft. of dip slip has placed Paleozoic limestones in contact with the Precambrian complex of the Magdalena Mountains. Related to the major fault are tension breaks along which the ore fluids ascended to replace favorable beds of the Kelly formation (Mississippian)

Distinct zoning of hydrothermal minerals has taken place spatially related to controlling faults. Geometry of the ore body, zoning, and paragenetic data indicate that control of the ore body is not directly related to tectonic shattering of early silicated beds. Deposition of metallic and gangue minerals appear to have been essentially contemporaneous and related to factors other than tectonics. Experimental evidence is cited to show that the hydrothermal deposition could have been closely related to a reaction gradient that may have been only slightly influenced by temperature but was closely related to a variation in pH and changes in the environment of deposition.--Auth.

3-3867. Adler, Hans H. SOME POSSIBLE GEOLOGIC RELATIONSHIPS IN THE FORMATION OF URANIUM^{235} FROM CURIUM^{247}: Econ. Geology, v. 56, no. 4, p. 689-694, table, June-July 1961, 14 refs.

A mechanism for the derivation of U^{235} from Cm^{247} is considered as a possible source of U^{235} enrichment in radioactive rare-earth minerals. The presence of Cm^{247} in early earth materials is predictable on the basis of synthesis through nuclear reactions and from extrapolations of abundances of lighter nuclides. The chemistry of Cm reflects a geochemical similarity to rare-earth elements and possible incorporation in rare-earth minerals. The amount of enrichment of U^{235} that might be expected from Cm^{247} decay is calculated for monazite for several geologic ages. Within the limits of the parameters considered, Cm^{247} would not provide sufficient U^{235} enrichment to be of economic consequence, but its possible existence in early geologic time may be of interest in geochronology studies. Underestimation of Cm^{247} abundance may affect significantly the probability for finding interesting variations in U^{235}:U^{238} ratios.--Auth.

3-3868. Ames, L. L., Jr. THE METASOMATIC REPLACEMENT OF LIMESTONES BY ALKALINE, FLUORIDE-BEARING SOLUTIONS: Econ. Geology, v. 56, no. 4, p. 730-739, 7 figs., table, June-July 1961, 30 refs.

A laboratory study of the kinetics of limestone replacement by alkaline, fluoride-bearing solutions is presented. Data on the effects of temperature, concentration (fluoride ion and cations), pH, calcite surface area, and flow rates on fluoride ion, Sr^{+2}, Ce^{+3}, and U (VI) removal are included. These data are discussed in relation to field occurrences of fluorite replacement deposits.--Auth.

3-3869. Ivankin, P. F. ZONING IN THE SEQUENCE OF SULFIDE DEPOSITS IN THE IRTYSH ZONE OF THE ALTAI: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 473-474, May-June 1959, pub. 1960, 4 refs.

The Irtysh sulfide series can be represented by a number of stages of ore zones between the 2 ore-forming end members, the Cu-pyrrhotite and Pb-Zn types. The principal stages are similar for the various positions in the column: first a pre-ore stage marked by metasomatic transformation in the host rocks, followed by an ore stage in which solutions with changing composition precipitated nonferrous minerals and smaller amounts of gangue minerals. The solutions of the pre-ore stage were at first volatile-rich and became denser with time. The ore solutions were at first enriched in Pb, Zn, Sb, Au, Ag, Cd, and tellurides. As the solutions advanced upward they became residually enriched in Fe, Mg, Cu, Ti, and Co.--F. Manheim.

3-3870. Rao, M. R. Srinivaso and B. L. Sreenivas. KOLAR GOLD FIELD, INDIA: Econ. Geology, v. 56, no. 4, p. 793, June-July 1961.

Discussion of GeoScience Abstracts 3-943. A few criticisms are offered regarding the geology and structure of the Au-bearing lodes as previously presented.--J. A. Chamberlain.

3-3871. Oder, Charles R. L., and James E. Ricketts. GEOLOGY OF THE MASCOT-JEFFERSON CITY ZINC DISTRICT, TENNESSEE: Tennessee, Div. Geology, Rept. Inv. no. 12, 29 p., 2 figs., 3 pls. (in pocket, incl. geol. map, scale 1 1/2 in. to 1 mi.), 1961, 22 refs.

The Mascot-Jefferson City district lies between Knoxville and Jefferson City. Detailed stratigraphy is tabulated in the report. Regional structures include unusual domes. Angular unconformity, 2 periods of brecciation, and distortion and displacement of structures indicate 2 or more periods of deforming stress.

Important sphalerite mineralization forms breccia and fracture fillings and replacements in the upper (Ordovician) half of the Knox dolomite. The mineralization and features that localize it appear to pre-date regional structures.

Dolomitization, silicification, bleaching, brecciation, and ore genesis are outstanding geologic problems. Medium- to brownish-gray coarse crystalline dolomite is considered diagenetic, and variable dark- and medium-gray coarse dolomite is considered epigenetic. Silicification and bleaching of strata and breccia preceded sulfide deposition in limited areas.

The origin of mineralized breccias and fractures is not fully explained. The breaking shows no direct relation to faulting. Collapse breccias, tension fractures, and thinning of the strata support the theory that attributes the shattering to dissolution and foundering in some ore shoots. There is considerable evidence of bedding-plane movements caused by compressive stress. Algal reefs appear to have played no causative part in the brecciation.

The deposition of the sphalerite has been variously ascribed to meteoric waters, hydrothermal solutions, and marine sedimentation. Observations leave each hypothesis unproved. The sedimentary theory fails to explain the epigenetic character of the ore, the lack of sphalerite in porous layers, the crossing of formational boundaries by the mineralization, and the location of the Zn deposits in areas of structural disturbance.

A program for further investigation of the problems is outlined in the report.--C. R. L. Oder.

3-3872. Smirnov, V. I., and T. Ya. Goncharova. ORE PEBBLES IN ROCKS OF THE HANGING WALL OF THE URUP COPPER PYRITE DEPOSIT IN THE NORTH CAUCASUS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 427-428, May-June 1959, pub. 1960, 3 refs.

The Urup deposit consists of a sheetlike layer of cupriferous pyrite lying on medium tuffs and quartz albitophyres. The ore fragments found in the hanging wall consist likewise mainly of pyrite, with small amounts of chalcopyrite, bornite, and fahlerz. It is believed that the ore pebbles indicate a partial disintegration of the ore bed during the formation of the hanging wall and therefore offer a means of dating the mineralization.--F. Manheim.

3-3873. Brown, Andrew. GEOLOGIC INVESTIGATIONS OF RADIOACTIVE DEPOSITS, 1942-1960; A BIBLIOGRAPHY OF U. S. GEOLOGICAL SURVEY PUBLICATIONS ON THE GEOLOGY OF RADIOACTIVE DEPOSITS: U. S. Geol. Survey, Trace Elements Inv. Rept. 777, 86 p., 1961.

This report, the last of a series of periodic reports covering investigations made by the U. S. Geological Survey on behalf of the Divisions of Raw Materials and Research of the U. S. Atomic Energy Commission, is a bibliography of U. S. Geological Survey publications stemming from the Survey's investigations of radioactive materials and deposits since 1942. The listings, which are complete as of Nov. 30, 1960, include not only reports on investigations carried on under AEC sponsorship, but those on U and Th geology and related subjects financed from the Survey's direct appropriation.

Entries in this bibliography are arranged under the following main headings: general publications on U and Th; reconnaissance for U and Th; U in sandstone-type deposits; U in carbonaceous materials; U in phosphates; U in limestones; investigations of Th and related elements; Be investigations. Each publication is listed under the category of its major interest.--From introd.

3-3874. Osterwald, Frank W., and Basil G. Dean. RELATION OF URANIUM DEPOSITS TO TECTONIC PATTERN OF THE CENTRAL CORDILLERAN FORELAND: U. S. Geol. Survey, Bull. 1087-I, p. 337-390, fig., 8 maps (under separate cover) incl. 2 col. geol., scale approx. 1:750,000, 1961, 55 refs.

The Cordilleran foreland is one of the major tectonic units of western North America. It includes the area between the Cordilleran geanticline and the interior platform and extends from the southern margin of the Colorado Plateau to the Rocky Mountain foothills in S.-central Canada. Within the foreland a series of simple anticlinal mountains alternates with broad asymmetric basins. Most of the surface structures, including flexures and high-angle normal and reverse faults, are the result of recurrent vertical movements of blocks in the Precambrian basement rocks. For convenience of description, the foreland is subdivided into 15 large tectonic units: 1) the Williston or Dakota basin; 2) the central Dakota terrace; 3) the Black Hills uplift; 4) the Lake Basin fault zone, Cat Creek fault zone, and Blood Creek syncline; 5) the Bighorn Basin, Bighorn Mountains-Pryor Mountains uplift, and Powder River Basin; 6) the Chadron arch uplift; 7) the Absaroka Mountains uplift; 8) the Owl Creek Mountains uplift, Wind River Basin, Sweetwater arch uplift and northern Laramie Mountains uplift; 9) the Wind River Mountains uplift; 10) the Green River basin and Rock Springs uplift; 11) the Uinta Mountains uplift; 12) the Great Divide Basin, Washakie basin, and uplift and basin complex; 13) the Sand Wash basin, Axial Basin uplift, and White River uplift; 14) Front Range-Park Range-southern Laramie Mountains uplift; and 15) the Denver basin and Hartville uplift.

Within the 15 tectonic units, U deposits can be related to the following large-scale structural environments: a) crests of large-scale anticlines; b) troughs of major basins; c) flanks of large-scale uplifts where smaller structures are arranged in echelon; d) flanks of large-scale uplifts where subordinate structures are parallel to the major structure; e) conjunctions of major structures where trends intersect or merge with loss of identity of one or all trends and without an associated pattern of smaller scale structures; f) conjunctions of major structures where trends intersect or merge with loss of identity of one or all trends and where subordinate structures are parallel to or in echelon with the trend of one or all major structures.

Many U deposits can be more closely related by second-order discrimination to small- to intermediate-scale structures. Repetitions of the patterns to which known deposits are related may provide clues to areas containing presently unknown deposits.--Auth.

3-3875. Boyer, Robert E. OCCURRENCE OF RADIOACTIVE FLUORITIC SANDSTONE, WET MOUNTAINS, COLORADO: Econ. Geology, v. 56, no. 4, p. 780-783, 3 figs., June-July 1961, 4 refs.

Dakota sandstone with a fluorite cement containing Th, U, and Zr occurs in the proximity of a Tertiary hypabyssal rhyolite stock at the southern end of the Wet Mountains. Field relations and proximity to the stock suggest a hydrothermal origin for the mineralization. Regional mapping indicates the age of intrusive activity is mid-Tertiary, and possibly younger. --Auth.

3-3876. McCauley, John F. URANIUM IN PENNSYLVANIA: Pennsylvania, Geol. Survey, Bull. M43, 71 p., 13 figs., 9 pls., 7 tables, 1961, 65 refs.

Forty-three U occurrences, presently uneconomic, were studied primarily within Pennsylvania. The great majority are in the Catskill formation of Devonian age and are of the "sandstone type." Similar occurrences are present in rocks of Mississippian and Triassic ages.

The occurrences are in gray to green zones within red-bed formations of continental origin. Mineralization is commonly associated with carbonaceous material in the form of plant fragments. Pyrite, bornite, chalcopyrite, galena, digenite, chalcocite, and covellite have been identified from the Devonian occurrences along with the secondary U minerals, uranospinite and metazeunerite. No primary U minerals could be identified, and it is believed the primary U occurs either as a urano-organic compound or as an oxide, very finely disseminated throughout the C.

X-ray spectrographic analysis shows that U, V, Fe, Cu, Pb, Zn, Ba, and As are present in varying quantities in the majority of the sandstone occurrences. U is the most abundant element in the Triassic occurrences, while the Mississippian are characterized by U and V and the Devonian by Cu and U.

Chalcopyrite occurs in an exsolution relationship with bornite. Experimental data indicate that the minimum temperature of formation of this pair may be less than 100°C. S isotope studies show significant depletion in S^{34}, although variation within single occurrences is not as pronounced as for the Colorado Plateau deposits. This evidence suggests that the S in the occurrences was derived from organically produced hydrogen sulfide.

The supergene and multiple-migration accretion genetic hypotheses are rejected. The S isotope data favor the "ground-water hydrothermal theory," although the possibility that some or all of the metals in these occurrences are derived from magmatic sources by lateral migration cannot be excluded.--Auth.

3-3877. Mawdsley, J. B. IRON ORE OCCURRENCES, NORTHWESTERN SASKATCHEWAN: Saskatchewan, Dept. Mineral Resources, Rept. no. 50, 19 p., 6 maps (5 in pocket, scale 2 in. to 1 mi., with magnetometric overlays), 1960, 7 refs.

A description of the geological features of certain magnetic anomalies within the area flown by airborne magnetometer surveys in 1954 [56°15'-57°N. 107°15'-108°W.]. The anomalies are related to metamorphosed Fe formation of sedimentary origin, containing magnetite as the most abundant Fe mineral. Further prospecting is recommended, using the sedimentary sequence as a guide. Surface evaluation is difficult due to heavy overburden in the area.--R. L. Cheesman.

3-3878. Khalifa-Zade, Ch. M. THE GENESIS OF THE SAMUR SIDERITE DEPOSITS OF SOUTH DAGESTAN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 455-457, map, table, May-June 1959, pub. 1960, 6 refs.

Lithofacies and lithological investigation of the Samur siderites indicate that these deposits were deposited in isolated basins of a shallow sea. It is believed that the $CaCO_3$ content of the siderite facies is similar to that in the open sea; the main difference is the appreciable dilution of this carbonate with Fe. An extraordinarily warm and damp climate is regarded as having given rise to intense chemical weathering of the rather featureless upper Aalenian landscape and the transportation of colloidal iron oxides to the basins, where they accumulated in the form of highly ferruginous clays. The differentiation of the Fe deposits into goethite-hydrogoethite, glauconite-chamosite, and siderite phases is regarded as associated with diagenetic processes.--F. Manheim.

3-3879. Khryanina, L. P. TRAPS OF DIFFERENTIATED INTRUSIONS ON THE RIVER BAKHTA AND IN THE LOWER REACHES OF THE STONY TUNGUSKA (WESTERN PART OF THE SIBERIAN PLATFORM): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 432-434, table, May-June 1959, pub. 1960, 10 refs.

Petrography, petrology, and regional development of the Fe-rich traps of Bakhta and Stony Tunguska areas is discussed. It is concluded that the different phases and associations of the traps are due to deeper differentiation phenomena. The position of the Fe ore deposits is ascribed to the formation of magmatic chambers in the vicinity of deep fractures in the sedimentary cover of the Siberian platform and the crystalline substructure.--F. Manheim.

3-3880. Yingst, Parke O. COLORADO CLAY: Colorado School Mines, Mineral Industries Bull., v. 4, no. 4, p. 1-8, map, 3 tables, July 1961, 17 refs.

Following a brief historical account of world clay usage,. data are given on specific clay minerals, geology and origin of clay deposits.

Colorado clay deposits are presented relative to location, geologic age, and economic significance. Special attention is given to production of clay in Colorado, current uses, and the future of the Colorado clay industry.

Physical, chemical, and firing properties of clay are noted with comments on testing and on industrial specifications.--W. C. Peters.

3-3881. Reeves, Corwin C., Jr. GEOLOGY OF CLEORA MINING DISTRICT GYPSUM DEPOSITS, WELLSVILLE AREA, COLORADO: Econ. Geology, v. 56, no. 4, p. 772-779, 6 figs., June-July 1961, ref.

The Permo-Pennsylvanian zeugogeosyncline of central Colorado was the site of extensive evaporite deposition, especially in the northwestern part of the trough. Gypsum crops out principally in the Meeker and Dotsero-Eagle areas, pinching out to the S. and E., but sporadic occurrences are known through South Park and as far S. as Coaldale. Primarily Pennsylvanian in age, the gypsum was forced into irregular domes and anticlinal accumulations by Laramide and younger movements.

Two major Pennsylvanian gypsum localities occur in the Wellsville area. A third gypsum occurrence is considered to be Quaternary in age. Since 1952 approximately 50,000 tons of gypsum have been removed from these deposits and sold as a soil supplement by the U.S. Soil Conditioning Company of Salida.--Auth.

3-3882. Lang, A. H. A PRELIMINARY STUDY OF CANADIAN METALLOGENIC PROVINCES: Canada, Geol. Survey, Paper 60-33, 54 p., 3 maps (in pocket, scale 1:7,603,200), 1961, 44 refs.

The study is an attempt to depict and consider the main Canadian distribution of known occurrences of 17 metals and their relation to regional geology, including tectonics. It consolidates information from several maps for individual metals compiled by various officers of the Geological Survey of Canada. These show known occurrences or areas containing occurrences of metals, based on mineral identifications or assays, but do not include occurrences in minute quantities. Two "composite" maps were compiled by the writer, omitting widely scattered occurrences; these accompany the paper. One deals with the main metals produced in Canada, except Fe: U, Ni (including Co), Cu, Au, Pb, and Zn; Fe was omitted because it is in a different order of abundance. The other deals with Be, Cr, Li, Mn, Hg, Nb, native Ag, Sn, W, and V. For comparison, a third map outlines the main geological regions and tentative geological provinces and subprovinces. The maps are on the scale of 1 in. to 120 mi. to permit comparisons with the Geological Map of Canada. The metallogenic and geological characteristics of various regions and subdivisions are discussed briefly. It is concluded that, although prospecting and other investigations are incomplete, the patterns probably foreshadow actual conditions; that the patterns show much but not complete correspondence with geological and tectonic patterns; that the distribution of metals is largely related to geological history, including the amount of erosion after metallization, but that other distributional features are probably related to the original composition of the crust or other causes; that further, more refined metallogenic studies are desirable, both on a country-wide scale and for smaller areas on better scales; and that some such studies should consider mineral and rock associations, geological classes of deposits, and trace-element associations.--Auth.

3-3883. Jenney, C. P. GEOLOGY AND ORE DEPOSITS OF THE MATTAGAMI AREA, QUEBEC: Econ. Geology, v. 56, no. 4, p. 740-757, 5 figs., table, June-July 1961, 19 refs.

The Mattagami area comprises some 750 sq. mi. approximately 120 mi. NE. of Noranda, Quebec. Less than 5% of the surface area is outcrop, and glacial overburden averages about 75 ft. with depths of 200 ft. in places.

Although the area has been prospected by conventional methods since 1928, the original ore deposit was located by an airborne magnetic and electromagnetic survey followed by similar work on the ground.

The Zn-Cu ores of the area are irregular replacement deposits in a series of typical Keewatin lavas, tuffs, and fragmentals. In general, the mineralized zone appears to extend around the W., NW., and N. sides of an area of basic intrusives known as the Bell River complex. Lineal extent of this mineralized horizon is about 25 mi.

The lava-tuff series dips moderately to steeply away from the central basic complex, and ore deposits have been found on minor anticlinal flexures adjacent to a key tuff horizon in the series.

At the end of 1959, published ore reserves for the area were 30 million tons averaging 12% Zn, 0.75% Cu, 0.02 oz. Au and 1.25 oz. Ag. Additional ore is being added to this total by extensive diamond drilling. The ultimate potential of Mattagami is still unknown. --Auth.

3-3884. Brett, P. Robin. A MAGMATIC-PEGMATITIC-HYDROTHERMAL SEQUENCE AT LACORNE, QUEBEC: Econ. Geology, v. 56, no. 4, p. 784-786, June-July 1961, 4 refs.

The area contains evidence for an unusually complete sequence from granodiorite intrusion followed by pegmatite emplacement, to high temperature quartz veining and, finally to low temperature carbonate mineralization. At the Lacorne mine, molybdenite and Bi occur in economic quantities along with other less common minerals: chalcopyrite, pyrrhotite, sphalerite, bismuthinite, beryl, and tourmaline.--J. A. Chamberlain.

3-3885. Michigan, Geological Survey Division. MICHIGAN MINERAL INDUSTRIES, 1959, by Harry O. Sorensen, and Emery T. Carlson: 107 p., 20 figs., tables, Lansing, 1960, refs.

The value of Michigan mineral production totaled $385,321,927 in 1959, an increase of 10% from the 1958 figure. Record highs were established in the value of shipments of cement, gypsum, lime, peat, sand and gravel, and natural salines. Cement ranked first in value followed by Fe ore, natural salines, sand and gravel, salt, Cu, petroleum, and stone. Metallic mineral value decreased 5% and fuel value increased 14% while nonmetallic minerals increased 17% to a new high.

Commodities in the nonmetals group, mainly construction and chemical materials, represented about two-thirds of the state's output of minerals.

The annual value of Fe ore and Cu prior to 1900 represented approximately 90% of the total value of all mineral products. The years 1895 to 1900, however, were important years for Michigan's nonmetallic industries, as the first successful portland cement plant was begun in 1896. Increasing quantities of marl, clay, limestone, and shale were required. The development of the salt industry at Detroit beginning with the year 1895 resulted in increased production of that product.

The nonmetallics grew slowly but steadily in value from 1900 to 1914, but following that year growth was rapid due first to demands for war materials, and subsequently to the great era of industrial expansion which began in 1922, with constantly increasing demands for construction and road building materials. Important new uses and new products were developed which added greatly to the mounting value of nonmetallic production. By 1929 this had reached a total of $71,000,000.

In 1929, 1924, and 1927 the values of nonmetallic minerals and mineral products surpassed those of Fe ore and Cu, and beginning with 1930 the nonmetallic definitely assumed the lead.

In volume of mineral production in 1959 in the United States, Michigan ranks: first in salt, peat, gypsum, and Mg compounds; second in Fe ore, sand and gravel, and bromine; fourth in cement and marl; fifth in Cu; sixth in stone.--From auth., p. 13.

The report is preceded by a brief preliminary summary of "The Mineral Industry of Michigan in 1960," prepared by Donald F. Klyce. According to the U. S. Bureau of Mines, mineral production in Michigan in 1960 was valued at $427 million, a 12% gain over 1959 due largely to increased output of Fe ore and petroleum.

3-3886. Stuckey, Jasper L., and Stephen G. Conrad. MINERAL INDUSTRY OF NORTH CAROLINA FROM 1954 THROUGH 1959: North Carolina, Div. Mineral Resources, Econ. Paper 67, 29 p., 3 figs., 22 tables, 1961.

During the period 1954-1959, the mineral industry in North Carolina reached an all-time high in both tonnage and value. The average annual value of the state's mineral production was $40,346,000, and the average annual tonnage was 21,168,548 tons. This represents an increase of 62.6% in value and 47.5% in tonnage over the previous reported period of 1946-1953.

Nonmetallic minerals, Cu, Fe ore, Pb and Zn, W, and by-product Au and Ag composed the mineral production of North Carolina during 1954-1959. Nonmetallic minerals are by far the most important mineral resources and accounted for approximately 90% of the state's total mineral production. In order of value, stone, sand and gravel, mica, feldspar, Cu, W, and clays are the principal minerals mined. In 1959, North Carolina led all states in producing feldspar, sheet and scrap mica, olivine, and Li minerals (spodumene). It was third in the production of talc and pyrophyllite combined and was the only state producing millstones.

The period was one of marked progress and expansion throughout most segments of the industry. In 1954, the state became a producer of Cu for the first time since 1944, and in 1959 production of Fe ore was resumed for the first time since 1936. Consolidations and mergers of crushed stone producers were a highlight of 1959. A total of 33 or more pits and quarries were involved in these mergers and acquisitions.

North Carolina is rapidly becoming an important manufacturer of stone, clay, and glass products. It is estimated that there are more than 100 plants of all types engaged in manufacturing products from mineral raw materials in the state. Taking into consideration the value of all rocks and minerals mined and processed in the state, plus the value of stone and glass products manufactured from both imported and native minerals, it is estimated that the average annual value of the mineral industry to the economy of North Carolina is in excess of $100,000,000.--Auth.

3-3887. Thomson, Robert D., and others. THE MINERAL INDUSTRY OF PENNSYLVANIA IN 1959: Pennsylvania, Geol. Survey, Inf. Circ. 43, 48 p., graph, 15 tables, 1961.

Production of minerals in Pennsylvania in 1959 continued to decline; total value dropped $18.2 million or 2% below 1958. Output in 1959 was the lowest in value since 1942, primarily because of decreases of 8% in anthracite and in bituminous coal and 3% in petroleum. Increased demand for cement, clay, lime, natural gas, Fe ore, sand and gravel, stone, and Zn was not enough to overcome the $44.7 million drop in 3 basic fuels.--Auth.

Reviewed in turn are mineral fuels, nonmetals, and metals, followed by a review by counties.

13. FUELS

See also: Geologic Maps 3-3570, 3-3571, 3-3583; Areal and Regional Geology 3-3592; Stratigraphy 3-3641, 3-3650; Geophysics 3-3700, 3-3745, 3-3753; Geochemistry 3-3785; Mineral Deposits 3-3887.

3-3888. Lvov, M. S. ON THE EFFECTIVENESS AND DISTRIBUTION OF GEOLOGICAL PROSPECTING FOR GAS AND OIL: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 6-A, p. 329-334, 5 tables, 1959, pub. 1961.

The paper gives figures on the total amount of exploratory drill holes in the period 1920-1958 in various regions of the U. S. S. R. as well as on the density of drilling in the individual regions and on the number of areas currently being explored. They resulted in the discovery of about 400 oil fields and 186 gas fields up to 1959, some of them of very great importance. --C. Voûte.

3-3889. Barby, B. E. PANHANDLE GAS HUNT SETS HOT PACE: Oil & Gas Jour., v. 59, no. 22, p. 210-211, 213-215, 217, May 29, 1961; no. 23, p. 128-130, June 5, 1961, 8 maps, 2 graphs, 2 secs., table, 3 refs.

A background of present development and a prediction of future gas production in Cimarron, Texas, Beaver, and Harper counties, northwestern Oklahoma. The area is referred to as the Panhandle even though it is slightly more extensive than the true Panhandle. The development history is dealt with briefly, along with geology and reserves. All data and maps show only gas statistics and development.

Part 1 deals with the geology of the area. The main part of the area lies on the western shelf of the deep Anadarko basin. The relationship of this basin to other major structural features of the Panhandle is shown. All the important producing horizons are shown on a type section. Part 2, entitled "Success for the Panhandle," deals with reserves and future gas production. Success will continue to hinge on correct correlation of producing zones.--L. M. Dane.

3-3890. Tamrazyan, G. P. SOME SYSTEMATIC CHANGES IN THE COMPOSITION OF GASES IN THE OIL-GAS DEPOSITS OF THE APSHERON PENINSULA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 478-480, 3 figs., May-June 1959, pub. 1960, 20 refs.

The composition of gases from producing horizons on the Apsheron peninsula is related to stratigraphic depth and lithology of the host reservoir rocks. It was found that methane concentration, specific gravity, ethane, propane, butane and heavier hydrocarbons, and carbon dioxide increase with depth. It was also noted that heavy hydrocarbons were enriched in finer grained reservoir rocks.--F. Manheim.

3-3891. Gardner, Frank J. FUTURE COURSE OF DOMESTIC EXPLORATION: Landman, v. 6, no. 9, p. 6-7, 57-65, Aug. 1961.

The most promising area for oil exploration in the United States lies along a NW.-SE. axis beginning in the Gulf of Mexico, through the Rocky Mountains, and projecting NW. through western Canada into central Alaska. To the 5 geologic requisites of a potential oil region (sedimentary volume, oil shows, unconformities, porosity, and structural development) must be added human requisites — the aggressive wildcatter and a favorable market. Specific unexplored and unexploited areas in the U. S. worthy of attention are cited. There is no such thing as a dry salt dome.--M. Russell.

3-3892. North Dakota Geological Survey. PRODUCTION STATISTICS AND ENGINEERING DATA, OIL IN NORTH DAKOTA, SECOND HALF 1960: 109 p., graphs, tables, May 1961.

Data are given on 91 oil and gas pools. Information for each pool includes: location, discovery date, discovery well, producing formation, datum, deepest test, oil wells, production data 1960 (2nd half), accumulative production data to Jan. 1, 1961, reservoir data. Also tabulated are production by pools, oil production by counties, salt water disposal, and drilling statistics. Data for the first half of 1960 were listed as GeoScience Abstracts 3-2434.--A. C. Sangree.

3-3893. Ohio, Division of Geological Survey. CONTRIBUTIONS TO THE OIL AND GAS INDUSTRY IN OHIO: Ohio, Div. Geol. Survey, Inf. Circ. no. 29, 83 p., 20 figs., 1961.

A collection of papers which were presented at the Fifth Winter Meeting of The Ohio Oil and Gas Association in Columbus, Ohio, March 3, 1961. The papers are: "Gas Recycling and Slim Hole Completions in the Clinton Sand," by Brady G. Johnson; "Are Clinton Sand Floods Economically Feasible?," by H. C. Slider; "Gas Repressuring Project — Clinton Formation," by A. A. Coburn; "Big Frac or Little Frac," by D. C. Hubbard; and "Cost Cutting with Cable Tool Drilling," by Berman J. Shafer.--P. Smyth.

3-3894. Ohio, Division of Geological Survey. SUMMARY OF OIL AND GAS ACTIVITY IN OHIO DURING 1960: Ohio, Div. Geol. Survey, Rept. Inv. no. 40, 96 p., 6 figs., charts, 1961.

During 1960, new holes completed for oil and gas in Ohio totaled 1,005, of which 250 were gas wells, 434 were oil wells, and 321 were plugged as dry holes. Twenty-one percent (215 wells) were drilled as exploratory holes in search of new petroleum reserves, either as extensions to existing pools or as new pool discoveries, and of these, 37% resulted in production. Seventy-seven percent of all pool wells drilled were productive. The most active county in Ohio was Wayne County, with 5 gas, 95 oil, and 12 dry completions.

Of special interest during 1960 was the continuing search for deep petroleum reserves in Ohio and adjacent Appalachian states. Thirty-one test wells were drilled into Lower Ordovician and Cambrian strata for oil and gas in Ohio during the year, 4 of which penetrated igneous rock. One successful gas well and one oil well were completed in the Upper Cambrian.

The report includes 5 maps of Ohio, showing oil and gas pools, gas pipelines, distribution of bedrock, location of counties and townships, and geologic structure. Most of the report is made up of a tabular summary of oil and gas well drilling and production, by county, and by producing zone.--P. Smyth.

3-3895. Ohio, Division of Geological Survey. PRELIMINARY SUB-TRENTON DATA SHEETS: Ohio, Div. Geol. Survey, Inf. Circ. no. 28, 20 p., map, scale 1:500,000, 1961.

A map of Ohio shows location of drill holes reaching sub-Trenton strata. Notations give the lowest formation penetrated and elevations below sea level of the top of the Cambrian. The data sheets give additional information for each well, including depths to major stratigraphic units and production.--P. Smyth.

3-3896. Lytle, William S., and others. OIL AND GAS DEVELOPMENTS IN PENNSYLVANIA IN 1960: Pennsylvania, Geol. Survey, Prog. Rept. 158, 50 p., 5 figs., 7 pls., 12 tables, 1961, 46 refs.

Exploration in Pennsylvania during 1960 resulted in the discovery of 1 new gas field, 8 new gas pools, and 1 deeper gas pool. It also extended several gas-producing areas and established a new producing-depth record for the state.

After drilling a dry hole to the Gatesburg formation (Upper Cambrian) in each of their 2 offshore blocks in Lake Erie, the New York State Natural Gas Corp. surrendered their acreage. The new producing depth record was established by the Robert I. Snyder No. 1 well in Somerset County when gas was found in the Oriskany at 8,574 ft. The outstanding discoveries were the DuBois and Helvetia pools in Clearfield County in the Punxsutawney-Driftwood field and the Baldwin Pool of Westmoreland County in the Johnstown field. The new field and new pools discovered during the year were the results of deep exploration.

Completions in Pennsylvania during 1960 totaled 871, or 121 more than in 1959. Of the current year completions, 836 were in proven fields, and 35 were exploratory tests. The total footage drilled during the year was 2,430,280 ft.

Oil pipeline runs totaled 5,942,000 bbls., or an increase of 3.2% over the 1959 figure of 5,760,000 bbls. (revised). Proven oil reserves as of Dec. 31, 1960, were estimated at 107,632,000 bbls. (revised) and distillate reserves of 2,110,000 bbls. Gas produced totaled 119,671,000 MCF. Gas reserves were estimated at 1,192,132,000 MCF at the end of the year. The total reservoir capacity for storage of natural gas in Pennsylvania is 454,251,634 MCF. The undeveloped acreage leased is estimated at 11,000,000 acres.

Out of 231 seismic crew weeks spent in the Appalachian basin, 104 were logged in Pennsylvania. A number of geological field parties were active during the year. The airborne magnetometer survey of the Appalachian basin area is nearing completion. This survey by a private company will cover 129,500 sq. mi. and will be completed in July 1961. The aeromagnetic maps will be offered to oil and gas companies for purchase.--Auth.

3-3897. Burshtar, M.S., and others. OIL AND GAS IN THE LOWER ALBIAN OF THE SOUTHERN USSR: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 6-A, p. 346-350, fig., 1959, pub. 1961.

The paper gives particulars of stratigraphy and the lithology of the lower Albian, the subzones of which are well-dated by characteristic ammonites and Foraminifera. The section begins with a group of sands overlain by argillaceous deposits. Porosity and permeability data of the sandy subzone are given, which has been traced from the northwestern Azov seaboard through the Pri-Caucasus into western Uzbekistan and eastern Turkmenia yielding commercial gas in many areas. It is believed that the lower Albian also on the Kara-Kum platform and in adjacent areas might have similar characteristics and may be of interest as potential oil and gas producers.--C. Voûte.

3-3898. Mashkovich, K.A. DIRECTION AND METHOD OF EXPLORATION OF NEW OIL AND GAS FIELDS IN THE STAVROPOL AREA ON THE VOLGA: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 5-A, p. 265-275, 7 figs. incl. maps, 1959, pub. 1961.

Many disappointing results have been obtained during the exploration of the Stavropol area, although its prospects are believed to be good. Several structural traps were found to be without commercial reserves, and oil deposits are sometimes found outside the apparently favorable traps. A paleotectonic study based on the analysis of 25 local uplifts, combined with a paleogeographic synthesis, showed the structures to have different histories of development and to have been formed either during the Devonian, the Carboniferous, or the Mesozoic-Cenozoic. Regular relationships were found to exist between time of formation of structures and hydrocarbon accumulations at various levels of the Devonian and of the Carboniferous. Moreover, favorable zones can be distinguished from those where either the facies is less favorable or where subsequent erosion destroyed deposits. In exploring for now buried structures with good prospects, attention has to be paid to the relationship between axes of first and second order structures and the isopachs of various potentially productive horizons.--C. Voûte.

3-3899. Gorin, V.A., and T.M. Gadieva. PETROLEUM ERUPTIVE PLUGS AND ASPHALT PEBBLES IN THE PLIOCENE DEPOSITS OF THE APSHERON PENINSULA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 126, no. 1-6, p. 435-437, 4 figs., May-June 1959, pub. 1960, 4 refs.

Two parallel chains of active and fossil mud volcanoes and gas seeps characterize the Apsheron peninsula on the western side of the Caspian basin. Fossil mud volcanic plugs are present as columnar forms up to 2 m. in height and intrude the base of the productive unit at its contact with the lower Miocene. Field evidence indicates that the plugs were eroded by streams of gas-permeated oil much as streams of oil containing sand erode the fittings of oil wells. Asphalt pebbles were formed through destruction of old solidified petroleum layers or by the burial of congealed oil from mud volcanoes. Both of these features are related to the period of vertical migration of oil and gas into the productive unit.--F. Manheim.

3-3900. Aladatov, G.M., and E.K. Kan. NEW DATA ON THE GEOLOGIC STRUCTURE AND OIL AND GAS POSSIBILITIES OF THE NORTHERN PART OF FERGANA: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 5-A, p. 283-286, map, profile, 1959, pub. 1961, 4 refs.

An outline is given of the geological structure of the northern part of the Fergana depression. It consists of a monocline, complicated by folding and some faulting, made up of metamorphosed and strongly deformed Paleozoic rocks, unconformably overlain by Jurassic, Cretaceous, Tertiary, and Quaternary deposits. The last periods of folding occurred during the Neogene-Quaternary. The axes of the structures have a more or less E.-W. trend. Moreover, the Paleogene and the Cretaceous, which both are oil- and gas bearing, show lateral changes in facies from N. to S.--C. Voûte.

3-3901. Maksimov, S.P., and V.S. Chemodanov. FORMATION OF OIL AND GAS DEPOSITS IN THE KUM DAG UPLIFT REGION: Geologiya Nefti-Petroleum Geology, in translation, v. 3, no. 6-A, p. 351-356, 2 figs., 2 tables, 1959, pub. 1961, 12 refs.

The stratigraphy and tectonics are described of 3 structural uplifts which form the Kum-Dag uplift zone which shows an E.-W. direction. The westernmost structure contains a gas condensate deposit occurring in 4 distinct horizons of the Pliocene; the structure in the center oil deposits is without gas caps in a large number of horizons. The easternmost structure is devoid of oil or gas. The typical distribution of oil and gas deposits is explained by lateral migration of the hydrocarbons from the W. to the E. and differential deposition of oil and gas in the lowermost traps at a rather early stage of the Pliocene. The central structure, the Kum Dag uplift, was not entirely filled, and therefore no hydrocarbons could reach the eastern structure. During later tectonic movements vertical migration within each of the productive uplifts took place, though in a varying degree, commanded by local tectonic features. In some cases this was accompanied by escape of part of the hydrocarbons and the N into the atmosphere.--C. Voûte.

3-3902. Samsonov, V.V. OIL AND GAS PROSPECTS IN THE SELENGIN DEPRESSION IN THE LIGHT OF HYDROGEOLOGIC RESEARCH: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 6-A, p. 341-345, table, 1959, pub. 1961, 10 refs.

The chemical composition is given of water samples obtained from the Miocene in deep holes drilled in the delta of the Selengin river, lake Baikal area. The sedimentary section consists of Mesozoic-Cenozoic fresh-water deposits, containing down to a depth of over 2,500 m. fresh water of the sodium bicarbonate type. They are compared with surface water and lake Baikal water, which contains predominantly Ca, and with water from the Quaternary and from the Pliocene, in which Na occurs as well as Ca. It is concluded that all occurrences of water are genetically related, although the water cycle in detail is highly complex as water exchange is difficult in many cases. Under the prevailing conditions the presence of fresh water in the underground does not indicate a hydrogeologically open system with active circulation with the surface. The water samples obtained at depth show indications of reducing conditions and contain traces of oil and gas; it appears warranted to resume exploration in this area. --C. Voûte.

3-3903. Rostovtsev, N.N., and T.N. Simonenko. THE SEARCH FOR OIL AND GAS IN THE WEST SIBERIAN LOWLAND: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 6-A, p. 335-340, 2 figs., 1959, pub. 1961.

The authors recommend concentrating exploration for oil and gas on areas where the Jurassic and lowermost Cretaceous have good reservoir characteristics, being composed of coarse material eroded from large islands of basement rocks protruding from the sea at the time of transgression. The most favorable conditions are found where these islands consisted of granite domes. Deposits of oil and gas have been found on the flanks of these structures. This poses the problem of finding granite domes in the underground by means of a combination of gravimetric and magnetic surveys.--C. Voûte.

3-3904. Dikenshtein, G.Kh. NEW DATA ON THE GEOLOGY AND OIL-GAS PROSPECTS OF THE WESTERN PART OF CENTRAL ASIA: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 5-A, p. 276-283, map, 1959, pub. 1961.

An outline is given of the geology and main structural elements of a large part of the Turkmen S. S. R. and of adjacent territories, and indications are given of its gas and oil possibilities. The area where huge gas deposits have already been found, including the Gazli field, may become the most productive of the entire Soviet Union. It comprises the Karakum platform with a basement made up of Paleozoic rocks; the W. Turkmen depression filled with Neogene and Quaternary sediments, which forms part of the vast S. Caspian downwarp; and 2 marginal downwarps with a complicated structure bordering the Karakum platform. The W. Turkmen depression is still continuing to develop. Many folds, uplifts, and downwarps are recorded in the various regions. The producing horizons belong to the Pliocene-Neogene and to the Cretaceous. The Paleogene also might be productive in some places. Large areas still remain to be prospected.--C. Voûte.

3-3905. Maryland, Bureau of Mines. THIRTY-EIGHTH ANNUAL REPORT...CALENDAR YEAR 1960: 30 p., illus., tables, [Annapolis?], 1961.

The eighty-fourth report on conditions of coal and clay mines and production statistics within the state. During 1960, a total of 759,686.03 tons of coal and 18,050 tons of clay were produced.--A. C. Sangree.

3-3906. Deasy, George F., and Phyllis R. Griess. FUEL COMPETITION IN PENNSYLVANIA'S ELECTRIC GENERATING INDUSTRY: Pennsylvania, Geol. Survey, Bull. M44, 54 p., 21 figs., 4 tables, 1961, 9 refs.

A major market for Pennsylvania mineral fuels producers is the commonwealth's electric generating industry, but competition among in-state and out-of-state fuels producers for this market is severe. Data relative to primary energy employed at 174 of the state's electric generating plants reveal significant geographical differences in types and sources of energy utilized. Resource proximity and transportation facilities account for most such differences, and these factors, when reduced to a monetary basis, indicate that selection of an energy type or source for use at a specific generating plant is largely determined by comparative delivered costs per unit of energy. Several courses of action are open to Pennsylvania's bituminous coal and anthracite producers which may enable them to expand their market territory and increase their share of the commonwealth's electric generating industry fuel market.--Auth.

3-3907. Luther, Edward T. THE COAL INDUSTRY OF TENNESSEE: Tennessee, Div. Geology, Inf. Circ. no. 10, 58 p., 16 figs., 5 tables, 1960, 40 refs.

The coal industry of Tennessee has a long history, extending back to pioneer days. The first recorded production was in 1814, and the first commercial-scale production was in 1832. The industry attained approximately its present size by 1907. Progress in the industry has been marked by a shift from hand labor to ever increasing mechanization. This trend probably will continue and intensify. Another significant trend has been the increase in strip and auger mining. Originally all Tennessee coal was mined underground, but now about one-third comes from stripping and augering. Transportation of coal to market also has become more efficient. Originally the coal was hauled by wagon or flat boat; now rail, barge, and truck transportation, or combinations of these, are available.

The coal-bearing rocks of Tennessee are of Pottsville (Early Pennsylvanian) age and are in the Cumberland Plateau physiographic province. The coal industry in this area is widely dispersed, and active mines exist in 18 counties.

The market for Tennessee coal has changed radically over the years. Major uses once included coke making, burning in railroad steam engines, and home heating, all of which have declined in importance. Most of Tennessee's production now goes to electric utilities, particularly the Tennessee Valley Authority. The price of Tennessee coal has risen from the earliest recorded figure of $1.25 per ton to a high of $5.47 per ton in 1948, but in more recent years it has averaged about $4.00 per ton.

The coal industry of Tennessee produced nearly 9 million tons of coal in 1956, the record year, although the value of this record production was exceeded by the $37 million total of 1948, when prices were higher. Employment in the industry has declined somewhat owing to mechanization but still exceeded 4,000 in the fiscal year 1957-1958. Annual expenditures by the industry are estimated at about $18 million and the total capital investment at more than $97 million. Known recoverable reserves of Tennessee coal total 1,024,762,000 tons and constitute about a 150-year reserve at the present rate of production.

The future outlook for the industry over a period of years seems favorable because of expected increases in demand for coal for electric utilities and other uses.--Auth.

14. ENGINEERING GEOLOGY

3-3908. Kobold, F. MEASUREMENT OF DISPLACEMENT AND DEFORMATION BY GEODETIC METHODS: Am. Soc. Civil Engineers, Surveying & Mapping Div., Jour., v. 87, no. SU2, p. 37-66, 33 figs., July 1961.

Many methods of determining terrain movements and deformations in structures have been used. However, geodetic methods provide the only means of determining absolute displacements.

All geodetic methods are based upon the measurement of angles or distances, or both. Triangulation involves measurement of angles; trilateration, measurement of distances; and traversing, measurement of angles and distances. Trilateration has not been used in this work, so far as the writer knows, but the development of electronic distance measuring devices may make this a suitable method in the future.

The precision required in this work varies considerably. Mean errors in location may vary from a few centimeters to a few tenths of a millimeter, depending upon the magnitude of the displacement. Measurement of displacements in structures must usually be very precise, as the results are used to verify the hypotheses used in the design of the structure.

It was necessary to provide new equipment in order to meet the extremely high precision usually required in this work. A basic principle in the development of this equipment was to use existing equipment as far as possible, making it suitable for specific purposes by means of inexpensive auxiliary equipment. Moreover, the auxiliary equipment was to be so designed that it could be used for various purposes rather than a single, specific use.

Various applications of geodetic methods to terrain movement and deformations in structures are described and specific examples given. The new equipment is described and shown in operation.--Auth.

3-3909. Moore, R. Woodward. GEOPHYSICS EFFICIENT IN EXPLORING THE SUBSURFACE: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 87, no. SM3, pt. 1, p. 69-100, 27 figs., June 1961, 18 refs.

Two geophysical methods, refraction seismic and electrical resistivity, are briefly described, their countrywide use mentioned, and numerous examples given of their application to a variety of subsurface problems pertinent to highway design and maintenance. Among these are studies of landslide conditions and tests made over water-covered areas.--Auth.

3-3910. Woodruff, Seth D. PRACTICAL USE OF ROCK MECHANICS: Mining Cong. Jour., v. 47, no. 7, p. 33-37, 55, diags., graph, July 1961, 5 refs.

The beam and the arch are the types of rock structures that can support themselves over an underground opening. A beam is self-supporting only if the rock is intact and possesses some tensile strength; otherwise, the self-support comes from the arching effect of stresses in the overlying rock.

The rock ahead of an advancing long wall face, or a retreating pillar line, is subjected to pressure exceeding the depth pressure. The zone of excess pressure is called the front pressure abutment. The zone of least ground pressure is located immediately behind the working face. Behind this, the ground pressure gradually increases until at the rear pressure abutment the ground pressure approaches or exceeds the depth pressure. The pressure arch spans the distance between the abutments.

The pressure arch is undoubtedly present around stopes and room-and-pillar systems. The squeezing of timbers, crushing of pillars, and heaving of soft floors may be alleviated by keeping the open distance along the strike in slopes or the total width of developed panels of pillars less than the span of the pressure arch.

In squeezing ground, a knowledge of rock pressures and angle of internal friction of soft ground is used to design the size of opening required to obtain a specified size after squeezing.

Rock bursts can occur because of compressive stresses built up by the arching effect over a fractured beam spanning an opening. The stresses may be relieved by drilling and blasting in the working face.--F. R. Hall.

3-3911. Parkin, Blaine R. IMPACT WAVES IN SAND: THEORY COMPARED WITH EXPERIMENTS ON SAND COLUMNS: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 87, no. SM3, pt. 1, p. 1-32, 12 figs., 2 tables, June 1961, 17 refs.

A phenomenological theory is developed in order to study the propagation of unidimensional compression waves in columns of sand. The medium of the theory is treated as an elastic-plastic continuum. It is assumed that each element of the substance exhibits a strain-rate effect such that, at a given strain, the plastic strain-rate is proportional to the difference between the compressive stress on the particle and that stress which would act on the element under static conditions. Published experimental results on the propagation of stress waves in sand are used as a basis of comparison between experiment and theory. The present theory gives satisfactory agreement with experiments on stress propagation in 2 dry sands.--Auth.

3-3912. Sandia Corporation, Sandia Laboratory, Albuquerque, New Mexico. HIGH EXPLOSIVE CRATER STUDIES: TUFF. By Byron F. Murphey: U. S. Atomic Energy Comm., [Pub.] SC-4574(RR), TID-4500 (16th ed.), 31 p., 7 figs., 14 contour maps and profiles, Apr. 1961, 6 refs.

Spherical charges of TNT, each weighing 256 lbs., were exploded at various depths in tuff to determine apparent crater dimensions in a soft rock. No crars were obtained for depths of burst equal to or greater than 13.3 ft. It was deduced that rock fragments were sufficiently large that charges of greater magnitude should be employed for crater experiments intended as models of nuclear explosions.--Auth.

3-3913. Davis, Robert E., and others. PRELIMINARY RESULTS OF A SURVEY FOR THICK HIGH-CALCIUM LIMESTONE DEPOSITS IN THE UNITED STATES. With a section on Possible Alaskan Sites for Nuclear Reaction Experiment in Limestone, by E. Donald Eberlein: U. S. Geol. Survey, Trace Elements Inv. Rept. 780, 45 p., 2 maps, 3 tables, 1961, refs.

Of the many areas that have received preliminary appraisal as potential sites for an underground nuclear explosion in a thick sequence of high-Ca limestone, 0 in the continental United States and 6 in Alaska appear to offer possibilities of meeting the primary criteria of purity and thickness. Field examination of these areas can be undertaken to determine whether they are suitable, but an approximation of the time involved suggests that 6 man-weeks of fieldwork would be required for each field appraisal. Further work would be required to locate sites in any of the areas that proved promising.--Auth. summ.

3-3914. Leonards, G. A., and A. G. Altschaeffl. SUBSURFACE MATERIALS OF MARION COUNTY, INDIANA: Purdue Univ., Eng. Ext. Dept., Eng. Bull., Ext. Ser., no. 103, [6] p., 10 figs., incl. maps, secs., profiles, Aug. 1960, 4 refs.

The report compiles available exploration records and presents typical profiles through the Indianapolis metropolitan area. The entire county is blanketed with Wisconsin glacial drift with underlying SW. gently dipping fine sandstones, shale, and carbonates of Paleozoic age. Passing through Indianapolis, the West Fork of White River and tributaries are filled with glaciofluvial sand and gravel, with a recent alluvial cover where the river has worked. The upland areas are composed of tough glacial till with isolated kames. Often a layer of glaciofluvial material is found between 2 till layers. Few foundation problems exist except in the soft weathered nearsurface soil zones, for the hard glacial till and compact glaciofluvials offer competent support for most structures.--J. E. Garrison.

3-3915. Sandia Corporation, Sandia Laboratory, Albuquerque, New Mexico. NUCLEAR EXPLOSIVES AND LANDSLIDE DAMS. By Roland H. Carlson: U. S. Atomic Energy Comm., [Pub.] SC-4403(RR), TID-4500 (15th ed.), 96 p., illus., maps, secs., diags., graphs, tables, Apr. 1960, 22 refs.

The possibility of constructing a rockfall dam by triggering a rockslide with nuclear explosives is explored. Seismic forces created by a deeply buried nuclear-explosive charge could initiate the slide, or the direct energy of nuclear explosives could be used to fracture the rock which would make up the slide mass. Problems discussed include spillway construction, seepage control, and those problems unique to the utilization of nuclear explosives. Destruction of undesirable natural slide dams is also considered. Appendixes cover desirable locations for a slide dam, descriptions of naturally created slide dams, and a Russian technique for creating slide dams by direct high-explosive blasting. A cost comparison is made for a slide dam constructed by use of conventional and nuclear techniques. It is concluded that slide dams could be successfully created by means of nuclear explosives.--Auth.

3-3916. Ogata, Akio. TRANSVERSE DIFFUSION IN SATURATED ISOTROPIC GRANULAR MEDIA: U. S. Geol. Survey, Prof. Paper 411-B, 8 p., 3 figs., 1961, 11 refs.

An analytical method of determining the ionic diffusion transverse to the direction of flow in granular media is presented. The basic assumption that the frontal zone created by longitudinal dispersion is fully developed and stationary before the transverse diffusion can cause spreading is made to simplify the mathematical analysis. Solutions were obtained in terms of both a series of Bessel's functions and a hypergeometric series. Numerical computations were made and results are presented in graphical form.--Auth.

3-3917. Todd, David K., and Jacob Bear. SEEPAGE THROUGH LAYERED ANISOTROPIC POROUS MEDIA: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 87, no. HY3, p. 31-57, 15 figs., May 1961, 28 refs.

The paper summarizes an investigation of seepage from leveed rivers into low-lying adjoining agricultural lands. Only the flow rate and distribution of seepage as a function of the surface and subsurface boundary conditions were studied. Flow nets in idealized cross sections were determined by an electric analogy model. Boundaries represented channel bed and bank, a levee base, a lower impermeable stratum, and the water table in adjoining drained agricultural land. Variables studied included 2 subsurface layers of different permeabilities and anisotropies, layer arrangements and thicknesses, channel depth and width, levee base width, and water table slope.--Auth.

3-3918. Bogdanoff, John L., and others. RESPONSE OF A SIMPLE STRUCTURE TO A RANDOM EARTHQUAKE-TYPE DISTURBANCE: Seismol. Soc. America, Bull., v. 51, no. 2, p. 293-310, 4 figs., Apr. 1961, 15 refs.

A physically plausible second order random function has been selected to represent ground acceleration. Several member functions have been presented in graphical form. Some of the statistical properties of the response of a simple structure to this acceleration have been determined, and possible uses of these properties by designers of aseismic structures have been commented upon. Lines for additional investigation of the uses of random function theory in the study of seismic disturbances also have been indicated.--Auth.

3-3919. WEST POINT SALVAGING PROPERTY AFTER FREAKISH WAVE HITS SHORE: New York Times, v. 110, no. 37,836, p. 80, col. 1-5, illus., Aug. 27, 1961.

Shearing collapse of as much as 1,000,000 cu. yds. of fill into the Hudson River at West Point, New York, on Aug. 26, 1961, caused a destructive wave 8 to 10 ft. high. The recently placed fill had projected 100 ft. into the river along 500 ft. of shore.--M. Russell.

3-3920. Einstein, H. A. NEEDS IN SEDIMENTATION: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 87, no. HY2, p. 1-6, March 1961.

The large storage reservoir is seen as the most important cause for new sediment problems in our rivers. Sediment transportation research should concentrate on the study of river conditions upstream and downstream from such reservoirs.--Auth.

3-3921. Busby, C. E. SOME LEGAL ASPECTS OF SEDIMENTATION: Am. Soc. Civil Engineers. Hydraulics Div., Jour., v. 87, no. HY4, p. 151-180, 2 maps, July 1961, 60 refs.

Legal aspects of sedimentation, of interest to the engineer, geologist, and soil scientist, are presented. The paper concerns rights in land, as deposited sediment and rights to water, as containing or transporting sediment. It also contains the rights to be free from undue damage caused by artificial changes in the movement and effects of water, involving sedimentation as a process.--Auth.

3-3922. Einstein, H. A., and R. B. Krone. **ESTUARIAL SEDIMENT TRANSPORT PATTERNS: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 87 no. HY2, p. 51-59, fig., March 1961, 2 refs.**

The sediment deposits most characteristic of est aries are muds which contain a large percentage of clays. These clays give the mud its particular qualities. The transport of these muds is largely determined by flocculation characteristic of suspended clays. The flocculation process is described and analyzed. The process of deposition and scour of the bed of these sediments is also described. All of these processes are finally combined in a descriptio of the process of shoaling in Mare Island Strait, an artificially deepened side arm of San Francisco Bay.' --Auth.

15. MISCELLANEOUS

3-3923. Ramsey, William L., and Raymond E. Burckley. MODERN EARTH SCIENCE: 630 p., 423 figs., 11 tables, New York, Holt, Rinehart and Winston, 1961, refs.

The position of the earth in the known universe is established through an introductory unit on astronomy. This is followed by a consideration of the general nature of the earth as a planet. Before the detailed study of surface features and the forces that shape them, a unit is given to consideration of the substances known to make up the earth's crust. The student is helped to recognize the role of chemistry in the earth sciences by the inclusion in this unit of a chapter on basic chemistry. Following the 2 units dealing with the major landforms and their origins, a unit is devoted to the earth's history as revealed by the fossil record. The concluding units deal with the liquid and gaseous portions of the earth - the water supply and the atmosphere. A final unit is concerned with a brief study of the causes and distribution of the world's climates, which are of such importance in regulating the lives of the earth's inhabitants.

Each chapter opening includes a vocabulary list. Technical terms are printed in boldface or italics where they occur in the text and are clearly defined. At the end of each chapter the vocabulary is reviewed in a section which the student may use as a self-quiz to test his understanding. A complete Glossary also appears at the back of the book. In addition to the Vocabulary Review at the end of each chapter there are 2 groups of Questions. At the conclusion of each unit there are Unit Review Questions and a group of suggestions for Activities and Further Reading to guide students who can make a broader study of the topics covered in the unit.--From auth. pref.

3-3924. Robertson, Forbes. **PHYSICAL GEOLOGY MANUAL OF LABORATORY EXERCISES: 151 p., 76 maps (2 col. in pocket, scale 1:62,500), 17 figs., 8 tables, Minneapolis, Minnesota, Burgess Publishing Co., 1961, refs.**

This manual is intended to introduce to beginning students of physical geology the common minerals and rocks, and, through the medium of topographic maps, those geologic agents which have sculptured the earth's surface.

The first 5 exercises deal with the common minerals and rocks. All the common rocks are classified according to those properties which the beginning student can distinguish in a matter of an hour of laboratory time. For the igneous rocks, the emphasis is placed on feldspars because feldspars are dominant in all common igneous rocks. In the sedimentary rocks there are a few innovations in classification sc far as an elementary treatment is concerned. But here again, the intent is to enable the student to com up with a reasonable answer with a limited amount of preparation.

The second group of exercises uses topographic maps to illustrate the effects that various geologic agents produce in forming landscapes. Instead of the student having access to maps in the laboratory for but a few hours a week, those segments of some 72 topographic maps (from 31 states) which reveal specific geologic features are incorporated into this manual.--From auth. pref.

The 17 exercises cover: igneous rock-forming minerals; igneous rocks; sedimentary minerals and rocks; metamorphic minerals and rocks; industrial and ore minerals; introduction to topographic maps - orientation, scale, symbols and location; contours an topography; the work of rivers; stages in the reductic of regions by streams; drainage patterns, antecedent and superimposed streams, and stream piracy; erosional remnants and ground water; valley glaciers an related features; continental glaciation; shore lines a sand dunes; volcanoes and volcanic rocks; topographi expression of faults and folds; lakes and lake basins.

3-3925. Sears, Mary, ed. **OCEANOGRAPHY. Invited Lectures Presented at the International Oceanographic Congress Held in New York, 31 August-12 September 1959: Am. Assoc. Adv. Sci., Pub. no. 67, 654 p., illus., maps, diags., graphs, tables, 1961, refs.**

The papers in this volume are not a summary of all existing knowledge about the oceans. They are focused on certain broad problems that have recently been under study as a result of new instruments, techniques, and researchers. Many are of geological interest. Contents are listed below:

HISTORY OF THE OCEANS

Shape and Structure of Ocean Basins, by Maurice Ewing and Mark Landisman.

Forces and Processes at Work in Ocean Basins, by E.

C. Bullard.
ratigraphy of the Deep-Sea Floor, by Edwin L. Hamilton.
he Biologist Poses Some Problems, by G.E. Hutchinson
rigin of Life on the Shores of the Ocean: Physical and Chemical Conditions Determining First Appearance of Biological Processes, by J. D. Bernal.
rigin of Life in the Oceans, by A. I. Oparin.
eological Record on the Ocean Floor, by Gustaf Arrhenius.

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aleobiogeogeography of the Marine Realm, by Preston E. Cloud, Jr.
iogeographical Boundaries: The Shapes of Distributions, by R. S. Glover.
volution in the Deep Seas, by G. S. Carter.
he Role of Ethology in Oceanography, by H. O. Bull.
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ultivation of Marine Organisms as a Means of Understanding Environmental Influences on Populations, by Trygve Braarud.

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eochemistry and Physics of Ocean Circulation, by W. S. Broeker and others.
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Abyssal Benthic Organisms: Nature, Origin, Distribution, and Influence on Sedimentation, by Anton F. Bruun and Torben Wolff.

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Coupling between Sea and Air, by Pierre Welander.
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Length of Pelagic Life in Marine Bottom Invertebrates as Related to Larval Transport by Ocean Currents, by Gunnar Thorson.
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CYCLES OF ORGANIC AND INORGANIC SUBSTANCES IN THE OCEAN

Interrelationships between Aquatic Organisms Mediated by External Metabolites, by C. E. Lucas.
Primary Production, by John H. Steele.
The Balance between Living and Dead Matter in the Oceans, by Johannes Krey.
The Physical Chemistry of Sea Water, by Lars Gunnar Sillén.
Chemistry in the Oceans, by Edward D. Goldberg.
Vertical and Horizontal Movements in the Ocean, by L. H. N. Cooper.

3-3926. Gould, S. H., ed. SCIENCES IN COMMUNIST CHINA. A Symposium Presented at the New York Meeting of the American Association for the Advancement of Science, December 26-27, 1960: Am. Assoc. Adv. Sci., Pub. no. 68, 872 p., 23 figs., tables, 1961, refs.

During the decade 1950-1960 of Communist control in continental China a large amount of Chinese scientific material has been gathered in various places in the western world. Up to now it has not been available to western scientists, partly because of the barrier presented by the Chinese language and partly because the relevant books and journals have been received in very few copies.

The present book represents a systematic effort on the part of American scientists, many of them of Chinese origin, to give a clear and unified account of this material. Their work has been based on about 250,000 pages of Chinese journals, for the most part photographed by a central library and distributed to the 30 authors. The 26 chapters provide a detailed survey of present-day science in Communist China.

Emphasis has been placed on the physical and biological sciences and on technology. The chapters on the social sciences are chiefly concerned with the political organization of science in general and with the effect on science of the social and political environment of the country as a whole.--A. A. A. S.

Papers in the symposium are listed below:

SCIENCE AND SOCIETY

Organization and Development of Science, by John M. H. Lindbeck.
Science, Scientists, and Politics, by Theodore Hsi-en Chen.
Education and Scientific Manpower, by Leo A. Orleans.
Anthropological Sciences, by Francis L. K. Hsu.

BIOLOGICAL AND MEDICAL SCIENCES

Botanical Sciences, by Hui-Lin Li.
Zoological Sciences Since 1949, by Tien-hsi Cheng.
Agricultural Science, by Ralph W. Phillips and Leslie T. C. Kuo.
Genetics and Animal and Plant Breeding, by C. C. Li.
Physiological Sciences, by Robert K. S. Lim and G. H. Wang.
Pharmacology, by E. Leong Way.
Medicine and Public Health, by William Y. Chen.

ATMOSPHERIC AND EARTH SCIENCES

Development of Geographical Science, 1949-1960, by Herold J. Wiens.
Geophysics, by J. Tuzo Wilson.
Progress and Outlook of Geology, by E. C. T. Chao.
Meteorology, Hydrology, and Oceanography, 1949-1960, by Malcolm Rigby.

MATHEMATICS AND THE PHYSICAL SCIENCES

Mathematics, 1949-1960, by Marshall H. Stone.
Nuclear Physics, by T. Y. Wu.
Solid State Physics, by Robert T. Beyer.
Chemistry, by Arthur J. Yu.
Astronomy, by Frank Bradshaw Wood.

ENGINEERING SCIENCES AND ELECTRONICS

Mining and Metallurgy, by K. P. Wang.
Progress in Electronics 1949-1959, by Yao Tzu Li and Way Dong Woo.
Electrical Engineering, by T. C. Tsao.
Civil and Hydraulic Engineering, by Lewis Li-tang Au.
Mechanical Engineering, by E. K. Nieh.
Chemical Engineering, by L. C. Pan.

3-3927. Whitcomb, John C., Jr., and Henry M. Morris. THE GENESIS FLOOD; THE BIBLICAL RECORD AND ITS SCIENTIFIC IMPLICATIONS: 518 p., 28 figs., Philadelphia, Presbyterian and Reformed Publishing Company, 1961, refs.

Scientific deduction from acknowledged geologic facts is claimed in this rejection of Lyell's theory of uniformitarianism in historical geology and Darwin's theory of evolution in paleontology. In order to reconcile the facts of geology with a literal interpretation of the Bible, divine creation of species and geologic catastrophism centering on the year-long, worldwide deluge must be accepted.--M. Russell.

Chapters deal with the following topics: basic arguments for a universal flood; basic arguments against an anthropologically universal flood; basic nongeological arguments against a universal flood; uniformitarianism and the flood; modern geology and the deluge; scriptural framework for historical geology; problems in biblical geology. Appendices deal with paleontology and the Edenic curse and Genesis 11 and the date of the flood.

3-3928. Pangborn, Mark W., Jr. GEOLOGY AND GEOLOGISTS IN FICTION: Washington Acad. Sci., Jour., v. 51, no. 4, p. 49-53, Apr. 1961, 26 refs.

A review of approximately 20 adult novels in English which feature geology or geologists. Science fiction, adventure novels, and detective stories are considered first. The author concludes with 4 serious novels which attempt to give their geologists authentic personalities and fit them into a real world.--L. M. Dane.

3-3929. Cramer, Howard Ross. ANNOTATED BIBLIOGRAPHY OF PENNSYLVANIA GEOLOGY TO 1949: Pennsylvania, Geol. Survey, Bull. G34, 453p., 1 fig., 1961.

Approximately 3,800 published articles and theses are annotated with regard to location, geologic ages, and subjects. Abstracts and biographies are also included. The index is to subject, county, and geologic age.--Auth.

3-3930. U. S. Library of Congress, Reference Dept. LIST OF RUSSIAN SERIALS BEING TRANSLATED INTO ENGLISH AND OTHER WESTERN LANGUAGES. Prepared by Robert McCollum and Elizabeth Petrov: 3d rev. ed., 28 p., Washington, D.C., 1961.

This bibliography lists 139 Russian serial publications currently being translated into English and other western languages. About 15 are in or closely related to the fields of geology, solid earth geophysics, and related areas of science. For each serial the following information is given: 1) the transliterated and translated title, 2) the Library of Congress call number, 3) frequency of publication, 4) date translation began, and 5) the translation's publisher. Names and addresses of publishers are listed separately. Index is by transliterated title and general subject. --M. Russell.

3-3931. Fan, Pow-Foong. GEOLOGICAL PERIODICALS OF MAINLAND CHINA: Econ. Geology, v. 56, no. 4, p. 786-789, June-July 1961, ref.

An annotated bibliography is presented of 21 periodicals devoted to geology. Fourteen additional journals are listed in which geological topics are occasionally found.--J. A. Chamberlain.

3-3932. Carder, Robert W. PHOTO TOPOGRAPHY FOR THE 1:1,000,000 LUNAR CHARTS: Photogramm. Eng., v. 27, no. 3, p. 386-390, 3 figs., June 1961.

Lunar photography taken from earthbound telescopes presents unique problems in the determination of lunar heights and interpretation of surface features. These problems are minimized by techniques used at the Aeronautical Chart & Information Center (ACIC), St. Louis, Missouri, in photo compilations of 1:1,000,000 scale lunar charts. Prof. Zdenek Kopal, University of Manchester, England, has refined techniques for determining heights of lunar features through shadow measurements. This method combined with reduction of other measurements of the lunar surface by the Austrian Astronomer Schrutka-Rechtenstamm has permitted ACIC to compile lunar charts with 300-m. contours having a probable error of 100 m. in localized areas. Visu observations of the moon for supplementing and confirming photo interpretation is being carried out at Lowell Observatory, Flagstaff, Arizona, by lunar cartographers. To support the ACIC lunar program an exhaustive collection of lunar photography is bein undertaken at Pic du Midi Observatory in the Pyrenee Mountains of southern France with prolonged cinephotography of the whole of the visible moon on 9-in. aerial film.--Auth.

3-3933. Hackman, Robert J. PHOTOINTERPRETATION OF THE LUNAR SURFACE (WITH FOLD-IN MAP SUPPLEMENT): Photogramm. Eng., v. 27, no. 3, p. 377-386, 11 figs., fold. map, scale 1:10,000,000, table, June 1961.

Photographs of the moon taken at different libratio positions have an angular difference of perspective, and hence stereoscopic photo interpretive methods may be applied to studies of the lunar surface. The common interpretation elements of shape, size, texture, pattern, position, and shadow are important criteria in the study of the moon, just as they are in the study of the earth's surface, although the phot interpreter must adapt to the novelty of extremely small-scale photography and must modify certain of the procedures and instruments used for conventional aerial photographs.

The dominant features of the lunar landscape are nearly circular craters, thought to be the result of meteoroid impact, and great lowland areas now floode with dark material believed by many to be lava fields. Relative ages of the lunar features may be determine from the degree of dissection of crater rims, and from the relative positions of craters with respect to the lowland and highland areas. In places the lunar surface is cut by conspicuous faults more than a hundred miles long. Many of these features, which bear on an understanding of the moon's surface and its development, have been compiled on generalized geologic and physiographic maps at a scale of 1:3,800,000. More detailed studies are being made and maps are being compiled at a scale of 1:1,000,00 for target areas for future lunar probes.--Auth.

3-3934. Shipek, Carl J. SURVEYING THE DEEP-SEA FLOOR WITH CAMERA: Photogramm. Eng., v. 27, no. 1, p. 84-91, 13 illus., March 1961, 8 refs

Underwater camera surveys are normally undertaken to study the character of deep-sea floor sediments and outcrops and the microrelief that results from the biological, physical, and chemical processes that create, alter and disturb the sediments. Bottom-contact and preset cameras with electronic-flash light sources are utilized in obtaining sea-floor photography. The first type, automatically activated upon bottom contact with a mechanical tripping device, provides vertical and high-angle photography. Successive photographs are taken by bouncing the tripping device on the bottom along the track of a vessel having a known set and drift. Distributions of free Mn nodules have been mapped, and the method is ideally suited for locating changes in bottom sediment type. Although aerial-type controlled mosaics are not obtainable with present cameras, several criss-crossing strips of underwater photographs with good navigational control will provide sufficient data to construct sediment charts, make known the general attitude of rock outcrops, and the presence of bottom currents through detection of ripple marks.

Underwater cameras preset to take photographs at various intervals usually provide low-angle photography and greater bottom coverage per photograph. Shadows resulting from the low-angle illumination are utilized to detect the very small relief resulting from benthic faunal activity and currents and waves of deep origin. This type of camera can also be used to study the concentration of biologic life in the vertical water column and the relationships to the bottom sediment. Time-sequence photography of the floor, coupled with dye release, should permit the determination of bottom-current velocities and the character of water motion near the bottom-water interface. Deep-sea cameras are presently being operated by only 6 institutions in the world; however cameras are being developed for use with bottom-traversing sleds and diving submersibles such as the bathyscaph. Stereo cameras are also being constructed for bottom photography.

In the field of underwater photographic mapping, the demand for better station positioning is paramount. Only when station keeping reaches a high degree of accuracy will even small-scale aerial-type mosaics of underwater areas be possible. Improved methods of photography must also be developed to contend with absorption and scattering of light through water.--J. R. Van Lopik.

3-3935. Walker, John E. PROGRESS IN SPECTRAL REFLECTANCE FILM-FILTER RESEARCH APPLICABLE TO ENGINEERING AND GEOLOGIC STUDIES: Photogramm. Eng., v. 27, no. 3, p. 445-450, 5 figs., June 1961.

More accurate and detailed information must be obtained from aerial photographs if photointerpretation is to become a more useful tool in engineering and geologic investigations. In the case where interpretation is primarily concerned with the detection of certain conditions or features, the photographic exposure should be determined by considering the reflectance properties of the ground objects themselves so that the resultant images will have the maximum contrast with their backgrounds. Detectability can be increased by using an aerial film-filter combination which is only sensitive to the spectral region over which the greatest reflectance difference occurs between an object and its background. The optimum spectral region is determined by on-the-ground spectrophotometric recording of object and background reflectance properties. Although optimum bandwidths may be fairly wide, evidence suggests that extremely narrow spectral band photography may prove to be an important aid in the process of detailed photointerpretation.

Problems involved in developing a narrow-band photographic system suitable for photointerpretation purposes include a) limitations of conventional aerial photographic techniques and methods in recording narrow spectral ranges, b) dynamic or temporal changes in background reflectance properties, and c) image variations resulting from nonuniform processing and printing. Nevertheless, by selecting presently available film-filter combinations to be flown at specific times and under specific conditions it is possible to increase the amount of detailed information extractable by photointerpretation. Narrower reflectance band aerial photography than is presently possible may provide a means of further increasing the quantity and quality of engineering and geological data which can be extracted by photointerpretation.--J. R. Van Lopik.

3-3936. Brown, Andrew. GEOLOGY AND THE GETTYSBURG CAMPAIGN: GeoTimes, v. 6, no. 1, p. 8-12, 40-41, 2 maps, July-Aug. 1961, 2 refs.

At the time of the Civil War the science of geology was young, and military geology, as the term is understood today, was years in the future. Yet the principles of military geology, applied or all too often not applied, influenced decisively the outcome of more than one campaign. The Gettysburg campaign is an excellent example of intelligent use by commanders of both armies of terrain and topography and, therefore, of geology.

The area of the Gettysburg campaign falls in 4 roughly parallel geologic-physiographic bands; 2 Triassic basins, the Culpeper in Virginia and the Gettysburg in Maryland and Pennsylvania; the Blue Ridge of Virginia and its continuation, South Mountain, into Pennsylvania; and the Great Valley of Virginia, Maryland, and Pennsylvania. The topography of these provinces channeled the opposing armies and determined to a great extent their relative positions on the Gettysburg battlefield.

The Battle of Gettysburg was essentially an effort by the Confederates to drive the Union army from the outcrop of the Gettysburg sill (Triassic) S. of the town of Gettysburg. The nearness of the diabase sill to the surface prevented the Union position from being entrenched, and as a result the Union casualties, as well as the attacking Confederate casualties, were extremely high.--G. L. Foster.

3-3937. Fryxell, Fritiof M. NATIONAL ASSOCIATION OF GEOLOGY TEACHERS: GeoTimes, v. 6, no. 1, p. 17-23, 43, 8 illus., July-Aug. 1961, approx. 7 refs.

The National Association of Geology Teachers, admitted to the American Geological Institute on July 6, 1954, was founded in May 1938, at Augustana College, Illinois, as the "Association of College Geology Teachers." It has since grown to almost 700 members.

The purpose of NAGT, as stated in its constitution, is "to foster improvement in the teaching of the earth sciences at all levels of formal and informal instruction, to emphasize the cultural significance of the earth sciences, and to disseminate knowledge in this field to the general public."

Besides the AGI, the Association is affiliated with the American Association for the Advancement of Science, and with the Geological Society of America, with which it annually meets. The Association awards Honorary Membership, by vote of the executive committee, and the Neil A. Miner Award "for eminence in stimulating interest in the earth sciences."

For the future, the NAGT has the prospect of growth with many new members both from the teaching force and from others qualified by reason of their interest "in disseminating geological information." With increased growth the NAGT plans to publish its semiannual Journal of Geological Education on a quarterly basis.--G. L. Foster.

3-3938. Decker, Robert W. THE FUTURE'S MARKET: Geo-Times, v. 6, no. 1, p. 13, 47, July-Aug. 1961.

Basing his impressions on the observations made during a recent American Association of Petroleum Geologists lecture tour, the author concludes that the depression in earth science enrollments is more severe than the depression in earth science professions. By 1962-1963, there will be more graduate stipends available than qualified, new graduate students; by 1963-1964, the present trend may make it even a more severe discrepancy. With the advent of increased employment opportunities, there will again be more job opportunities than prospective employees.

As part of the solution, more statistical presentations of employment projections are needed, particularly by the petroleum industry and by governmental agencies. Students can be informed of employment trends and special areas of interest so that they can make their own decisions. High curriculum standards should be maintained; and the concept that a good geology curriculum is rooted in mathematics, physics, and chemistry must be encouraged.--G. L. Foster.

3-3939. Hutchison, Charles S. UNIVERSITY OF MALAYA GEOLOGY DEPARTMENT: GeoTimes, v. 6, no. 1, p. 30-31, 3 illus., July-Aug. 1961.

Geology was first offered to science students in the University of Malaya in 1956. Initially, the geology department took up to 14 first-year students. A new campus was established in Jan. 1959, and in Apr. 1960, the geology department was moved from the old Singapore campus to the University in Kuala Lumpur. The new department began 1960-1961 with over 60 first-year students and 4 staff members. A fifth teaching staff member was provided for the department in Jan. 1961.

The present emphasis is on petrology and determinative mineralogy. Acquisitions of new equipment and building expansions assure that the University of Malaya will have one of the best housed and best equipped departments in Asia. The geology department has a role to supply honor graduates to staff the exploration sections of numerous mining companies. --G. L. Foster.

3-3940. Beebe, B. Warren. WHITHER GEOLOGY AND GEOLOGISTS?: GeoTimes, v. 6, no. 1, p. 14-16, July-Aug. 1961.

The author, as moderator, summarizes a symposium by 6 prominent, concerned geologists, on the topic of this article. The symposium, held Apr. 24, 1961, was a feature of the annual meeting of the American Association of Petroleum Geologists in Denver.

The discussion covered past, present, and future; academic training; employment; unemployment; opportunities; and concern of universities, professional organizations, geological surveys, and industry over the current plight of geology and geologists.

The panel concluded that employment and security are an individual responsibility; no professional organization of scientists can guarantee employment or tenure to its members. Nevertheless, geologists, through professional organizations, can and must attract the best qualified candidates, insist on the necessary adequate and rigorous training, develop and maintain high professional standards and pride in attainments as scientists rather than "job holders," exploit every conceivable opportunity for expanding the manifold uses of geology and talents of geologists and continuously and energetically educate the public to the cultural and economic benefits of geology. These are the means by which the profession's problems can be solved.--G. L. Foster.

3-3941. McMahon, Allen J. SPACE EXPLORATION, A CONTINUING EFFORT: Geophysics, v. 26, no. 3, p. 374-393, 17 figs., table, June 1961, 11 refs

Space exploration is carried on for political, scientific, military, economic, and psychological reasons. Today, sound, practical reasons exist to continue and extend the use of satellites to improve methods of meterology, communications and navigation, to name only a few. Scientific discoveries accruing from sound, well-planned space exploration, and their influence on American industries, can only dimly be foreseen. Further exploration effort promises to increase and emphasize the role played by the sun in a wide variety of human activities. The satellite Explorer VI and the space probe Pioneer V have extended communications to ranges of 20,000,000 mi. have increased scientific knowledge of the properties of the exosphere with respect to magnetic fields and energetic charged particles.

The space between the planets, far from being empty, is repeatedly being disturbed by great clouds of ionized gas called plasma. These are examples o the unusual and intriguing problems awaiting space exploration. Solution of these and unknown problems can best be achieved by continuous and diligent effort The part played by the United States in space exploration has been excellent to date. The long range payoff of such superb effort can scarcely fail to enrich this country, initially, militarily and eventually economically.--Auth.

3-3942. Hibbs, Albert R. THE NATIONAL PROGRAM FOR LUNAR AND PLANETARY EXPLORATION: Jour. Geophys. Research, v. 66, no. 7, p. 2003-2012, 8 figs., 3 tables, July 1961.

The National Aeronautics and Space Administration has assigned to the Jet Propulsion Laboratory of the California Institute of Technology the responsibility for design and development of spacecraft for the exploration of the moon, the planets, and interplanetary space. In carrying out its assignment, JPL, the United States' oldest guided-missile and rocket-research laboratory, is designing and fabricating spacecraft to be flown past the moon and to land scientific equipment on the surface of the moon. Designs have also begun for spacecraft to fly past the planets and land capsules of scientific instruments on the planetary surfaces. This paper describes the Ranger spacecraft, now undergoing assembly, which will initiate the lunar exploration program; the Mariner, now being designed, which will initiate the planetary program with a flight past Venus; and the Surveyor, in which packages of scientific instruments will be soft-landed on the moon. --Auth.

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